PETROLEUM REFINER

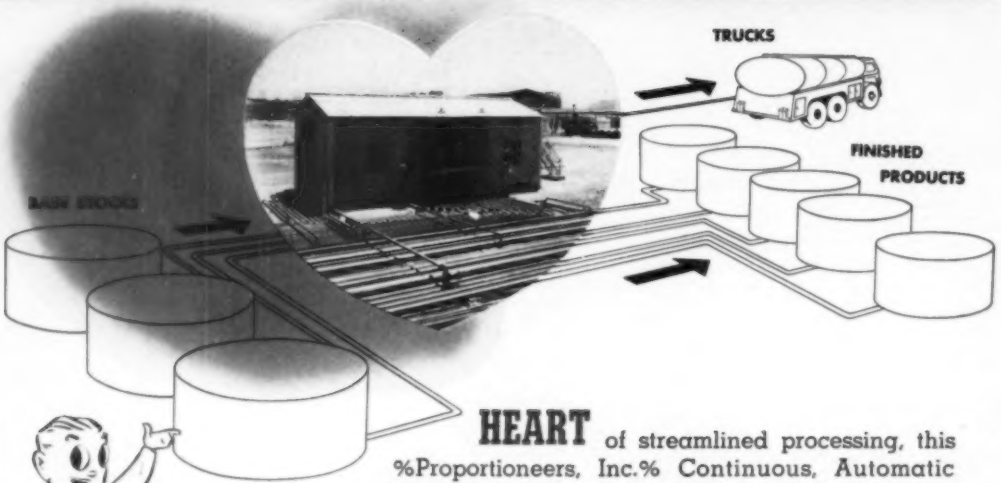
IF IT'S TUBE CLEANING...
...IT'S LAGONDA!
...same as it has been since the first tube still was built. Lagonda cleaners showed the way then, and they're still doing it... If you don't know how well they work, a tryout could be mighty interesting. Tell us when.

ELLIOTT COMPANY

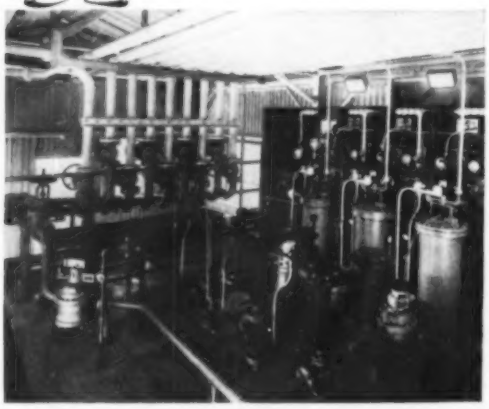
LAGONDA DIVISION • SPRINGFIELD, OHIO

DISTRICT OFFICES IN PRINCIPAL CITIES

BLEND COMPONENTS



HEART of streamlined processing, this %Proportioneers, Inc.% Continuous, Automatic Blender combines base stocks and additives. It provides new speed, flexibility and economy in the production of uniform blends. The system reduces manpower, eliminates blending tanks, agitation, auxiliary pumps and attendant piping. Because the finished product is immediately available, tank trucks can be loaded without waiting. The %Proportioneers, Inc.% Continuous, Automatic Blender, preset to formula, controls component ratios and permits quick adjustment of output to suit demand rates. This installation at refinery of Richfield Oil Corporation at Watson, Calif., delivers a variety of finished products, exactly to formula, to trucks and/or storage tanks.



Ask for recommendations and descriptive literature

% PROPORTIONEERS, INC. %

Write to %PROPORTIONEERS, INC.%, 412 Harris Ave., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

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PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President A. L. BURNS, General Manager
VOLUME 30, NO. 9 SEPTEMBER, 1951

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Look at the Whole Picture...

WHEN SELECTING LEVEL CONTROLLERS

Use the C_Q Method—Evaluate All the Quality Factors

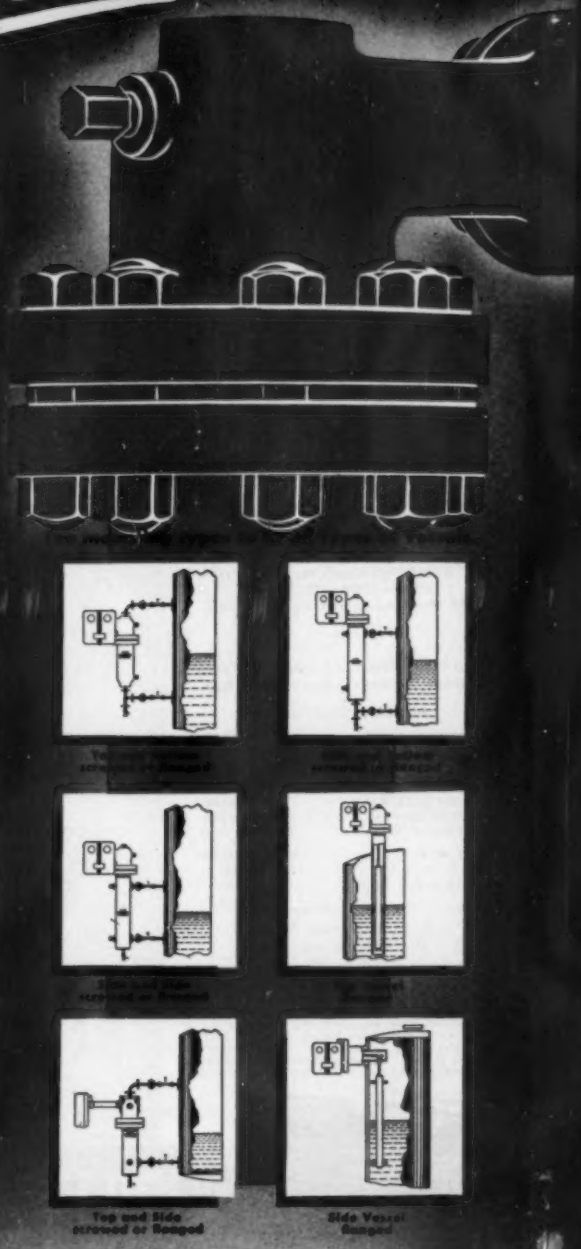
One well designed and manufactured part does not make a level controller that will "provide accurate performance over a long period with a minimum of maintenance and operation delays." *Every* part must be designed and manufactured so that all combine to make a controller which incorporates wise selection of materials for the intended service; skillful design for accurate operation; and experience which forestalls the difficulties you are likely to encounter in the field.

So in selecting level controllers, use the C_Q Method — evaluate *all* the quality factors in relation to your standards. The sum of the value of all these factors is the C_Q (Quality Coefficient). A product with a high C_Q will give you the performance you have a right to expect. And in considering price, don't forget the over-all cost* is lowest for a high C_Q product. For comparison purposes — among comparably priced controllers

$$\text{Real Cost} = \frac{\text{Price}}{C_Q}$$

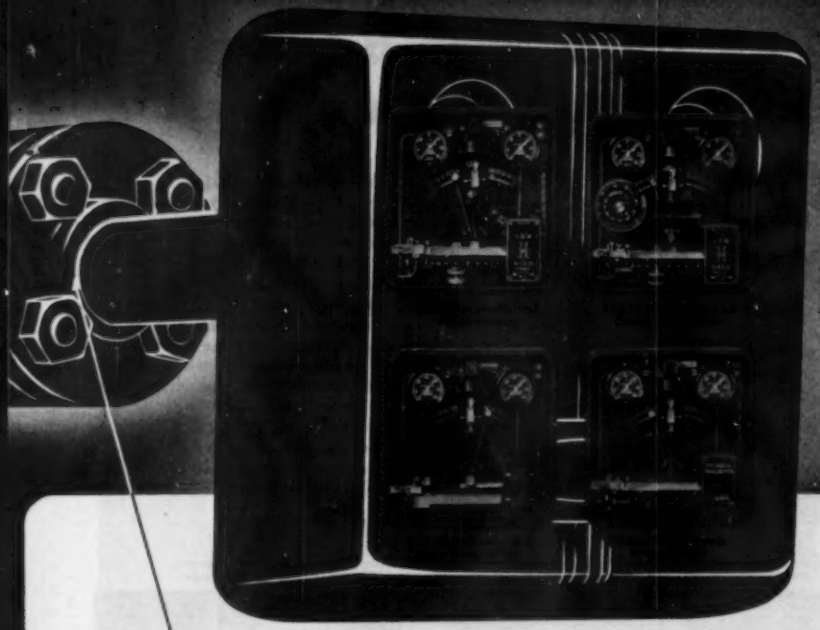
Look at the whole picture — use the C_Q Method — evaluate *all* the quality factors.

*Purchase price plus cost of maintenance and down-time.



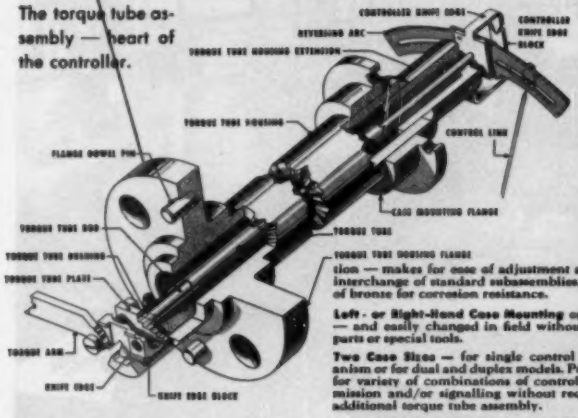
THE MASONEILAN 12000 SERIES LEVEL CONTROLLERS

A High C_Q Product



Three Standard controller types and the transmitter (also pneumatic switch) in the standard case; dual or duplex combinations of these in a larger case.

The torque tube assembly — heart of the controller.



Note the Quality Factors of the Masoneilan 12000 Series Level Controllers

Sturdy Instrument Case with ribbed reinforcements to prevent distortion due to temperature and handling which might create inaccuracy in control mechanism. Aluminum with Weatherproof finish and Gasketed door — protect against effects of weather and corrosive atmospheric conditions.

One Piece Air Manifold eliminates much of air piping inside case — simplifies construction — makes for ease of adjustment and for interchange of standard subassemblies. Made of bronze for corrosion resistance.

Left- or Right-Hand Case Mounting optional — and easily changed in field without extra parts or special tools.

Two Case Sizes — for single control mechanism or for dual and duplex models. Provides for variety of combinations of control transmission and/or signalling without requiring additional torque tube assembly.

Large Capacity Relay-type Pilot Design insures instant response to variations in nozzle pressure. Includes metering tube for constant nozzle supply. Fastening directly to manifold avoids air piping. Uses minimum air supply.

Simple Proportioning Mechanism: Minimum number of parts, simplified linkage, use of proportional leaf spring — insure instantaneous response. All adjustments simple, with clearly visible scales. Action reversible by one simple adjustment. Proportional band setting independent of specific gravity; scale provides wider graduation spacing in lower settings; causes minimum upset to process because alignment spring, leaf spring and proportional bellows forces in equilibrium at midpoint of output pressure range. Simplified linkage and flexure bearings eliminate lost motion.

Automatic Reset Mechanism: Adds reset response to proportional response. Simple unit adjustable over spiral scale with wider graduation spacing in lower reset rate settings.

Differential Gap Mechanism: Substitutes proportional on-off action for standard proportional action. Provides for adjustable gap between high and low limits.

Selection of Supplementary Functions: Design provides for pneumatic transmitter, pneumatic or mechanical signal switch using same torque tube and displacer assemblies.

Dual and Duplex Types: Selection of combinations of control mechanisms, controller plus transmitter, controller plus switch, etc. — in *one case*; using only *one torque tube* assembly.

Simple Mechanical Indicator inside case provides serviceman with reliable, direct indication of level; has no complicated linkage — requires no field calibration.

Torque Tube Assembly design provides
(a) selection of materials — inconel, monel, stainless steel, bronze.

(b) all parts of torque tube subassembly of same alloy — avoids contamination of the weld.

(c) fabrication by latest type inert arc welding equipment and methods.

(d) knife-edge bearing at each end insures true center of rotation — cannot be off-centered by high temperature or practical tolerances in fabrication — eliminates objectionable friction.

(e) Torque tube length, wall thickness and diameter selected for most desirable combination of low operating stress and load carrying ability.

Displacer Hanger has modified knife-edge bearing at connection to torque arm. Integral or detachable extensions available for internal mounted displacers.

Displacers made of stainless steel tubing; designed so that standard control mechanisms may be used without modification, for all applications.

Selection of Mounting Types available to meet all vessel requirements. Choice of 9 Level Ranges between 14" and 15 ft. (standard). Special ranges may be supplied.

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1182 Adams Street, Boston 24, Mass., U. S. A.

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Looking for tubes with a better life/cost ratio? Ask the experts!

This month's report is on:

SILMO

Offers good combination of high temperature strength and oxidation resistance. At 1000°F. — 1150°F., it has about twice the strength of carbon steel and oxidation resistance comparable to 4-6 Cr. Mo. For use in cracking furnace, heater, high pressure boiler and superheater tubes.

ONE OF 23 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 9S	16-13-3
Carbon-Mo.	Sicromo 2½	Sicromo 3MS	25-20
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-12
Silmo	Sicromo 5	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

*Not available as seamless tubing at the present time.

If your high temperature tubes either fail too soon or last longer than needed, they're costing you too much. Only *one* high temperature steel can give you the best life/cost ratio. It's the one that's tailor-made for your particular operating conditions.

To make sure you get the *right* steel, consult the recognized authorities in this field—the Timken Company metallurgists. Their recommendations are backed by 21 years of pioneering research and the widest field experience. They have 23 analyses to choose from. And uniform tube quality is assured by our complete control from melt shop through final inspection.

Let the Timken Company's "RSQ"—Research, Supply, Quality—solve *your* tube problems. Ask the experts! The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, O. Cable address: "TIMROSCO".

Photo shows metallographic laboratory at the Timken Company, where structural characteristics of high temperature steels are determined. The Timken Company was first to test high temperature steels, and still leads in that research today.

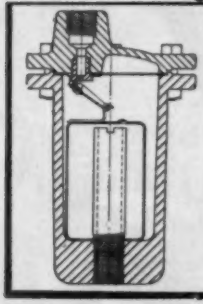
YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing

"Here's a Forged Steel Trap ... for only $20.00 list"

SMALL PRICE
BIG BENEFITS

SAFETY . . . DEPENDABILITY



Cross section of an Armstrong No. 3211 forged steel trap. Forged cap and body, compressed graphited asbestos gasket, all stainless mechanism. This trap will take high temperature and shock without danger of fracture.

SMALL SIZE.. LIGHT WEIGHT

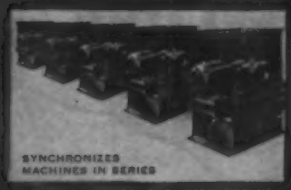
NOW, for many applications, refineries and natural gasoline plants can have the additional safety of a forged steel steam trap for only a few dollars more than a cast iron trap of comparable size. The Armstrong No. 3211 trap illustrated will withstand fire or explosion without danger of fracture. It is the baby of the Armstrong forged steel line, a low priced trap for working pressures up to 250 psi; design pressure, 450 psi. Capacity range 750 to 1000 lbs/hr continuous. ½" or ¾" pipe connections. Diameter 4¼"; height 7"; weight 8 lbs. This trap is a natural for refinery and natural gasoline plant service.

For higher pressures and larger capacities Armstrong builds a complete line of heavy duty forged steel traps. Ask your nearby Armstrong representative to quote on the traps you need now.

ARMSTRONG MACHINE WORKS
852 Maple St., Three Rivers, Mich.

SEND FOR your copy of the Armstrong Steam Trap Book giving complete data and prices on all Armstrong steam traps, both forged and cast bodies for all pressures, all applications. This 36-page book is a valuable reference for any engineer working with selection and installation of steam traps.

ARMSTRONG STEAM TRAPS



makes a good job better

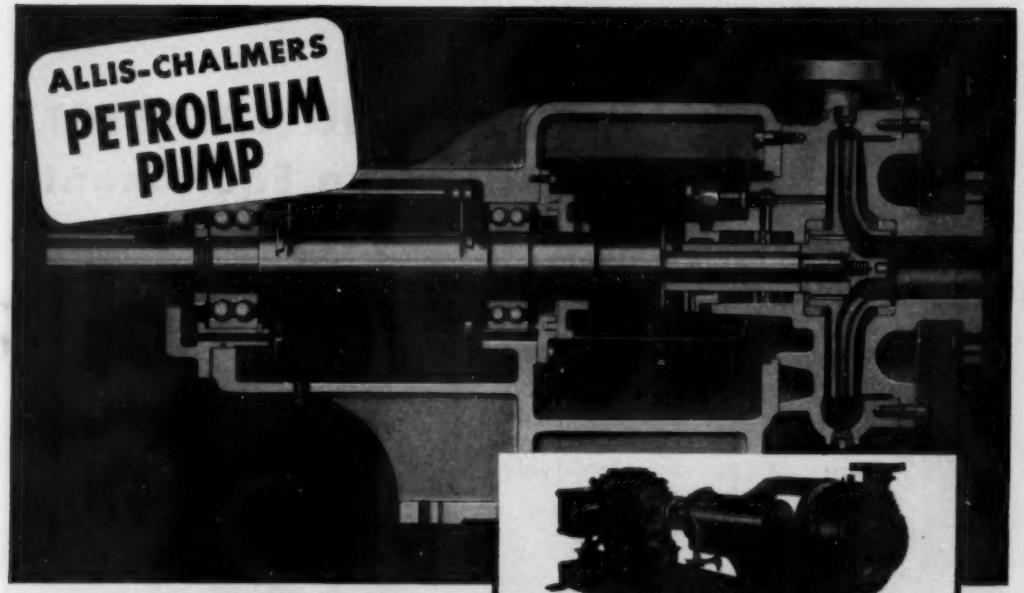
Better because variable speed operation pays off in higher rates of production, a more uniform better quality product and more efficient performance of your equipment and your operators.

Make the job better still by using Master Speedrangers because their all-metal construction makes them extremely compact and durable . . . more flexible and adaptable to a wide range of uses. They're available in sizes up to 5 horsepower with speed ranges up to 12 to 1 in most sizes.

Write for descriptive booklet Data 7525 and see how Master Speedrangers can help you get better results on material processing, handling and conveying equipment . . . mixers and agitators . . . machine tool drives . . . testing and calibrating equipment and many other applications.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

MASTER SPEEDRANGERS



NEW Specially Designed for Processing Operations

★ Choice of Materials
★ Oil Lubricated Bearings
★ Temperatures to 500° F.
★ Sizes to 1200 GPM, 250 Ft Head
★ Stuffing Box or Mechanical Seal

LONG LIFE, high efficiency, easy maintenance; you get them all from this new Allis-Chalmers Petroleum Pump. A wide choice of materials plus application engineering by men who know how to select the right material for your job means longest possible parts life and low maintenance costs no matter what you pump.

There is plenty of room between pump and pedestal for easy maintenance but rigidity has not been sacrificed. Maximum interchangeability of parts between sizes keeps parts inventory low.

ONE DEPENDABLE SOURCE

Allis-Chalmers can supply you with a complete pumping unit—pump, motor, drive and control — all of coordinated design and manufacture and all mounted on a rigid base ready to install.

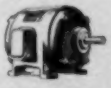
To get more information on this new Allis-Chalmers Petroleum Pump, call your Allis-Chalmers Authorized Distributor or District Office. Or write to Allis-Chalmers, Milwaukee 1, Wis. for Bulletin 52B7638.

A-3439

Texrope and Vari-Pitch are Allis-Chalmers trademarks.

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.



MOTORS — ½ to 25,000 hp and up. All types.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

ALLIS-CHALMERS

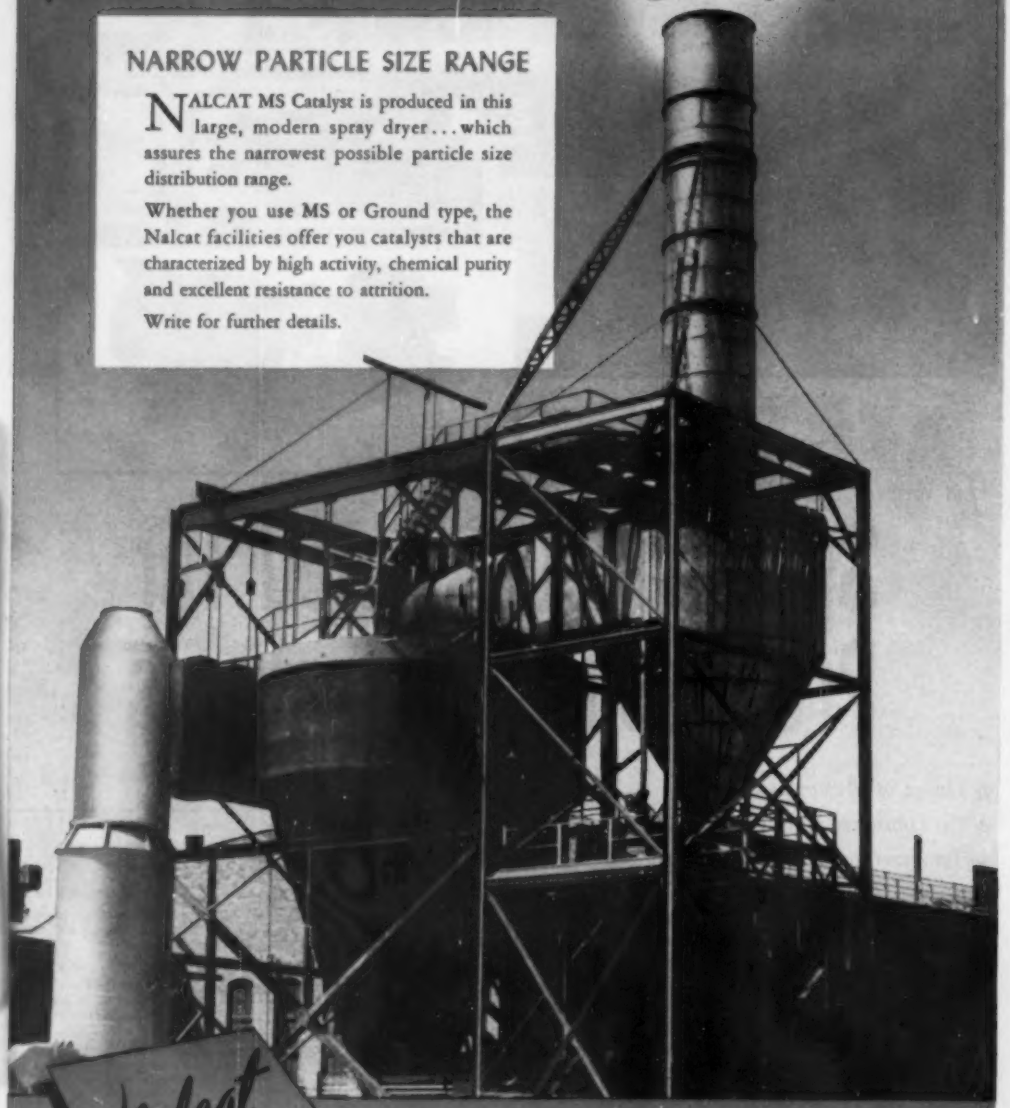
Nalcat MS CRACKING CATALYST
from Latest Design Equipment

NARROW PARTICLE SIZE RANGE

NALCAT MS Catalyst is produced in this large, modern spray dryer . . . which assures the narrowest possible particle size distribution range.

Whether you use MS or Ground type, the Nalcat facilities offer you catalysts that are characterized by high activity, chemical purity and excellent resistance to attrition.

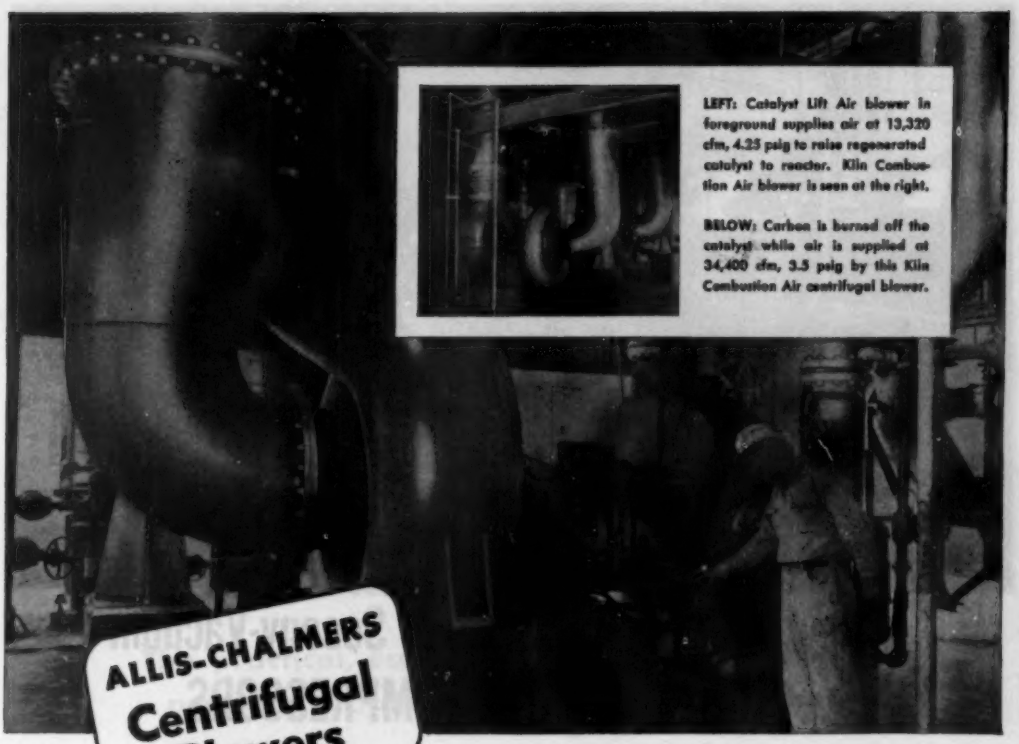
Write for further details.



Nalcat

MS AND GROUND TYPE CRACKING CATALYSTS

CATALYST DIVISION—NATIONAL ALUMINATE CORPORATION
4001 West 71st Street • Chicago 29, Illinois



LEFT: Catalyst Lift Air blower in foreground supplies air at 13,320 cfm, 4.25 psig to raise regenerated catalyst to reactor. Kiln Combustion Air blower is seen at the right.

BELOW: Carbon is burned off the catalyst while air is supplied at 34,400 cfm, 3.5 psig by this Kiln Combustion Air centrifugal blower.

ALLIS-CHALMERS Centrifugal Blowers

Help New Cracking Methods

AS CRACKING METHODS IMPROVE, more centrifugal blowers are being employed. The Allis-Chalmers single stage blowers seen here are essential to the three new Thermofor Catalytic Cracking units installed by the Magnolia Petroleum Co. at Beaumont, Texas.

Placed "on stream" last Fall, a total of six turbine-driven A-C blowers provide Kiln Combustion and Catalyst Lift Air in the Blower Room of the new catalytic structure.

The high efficiency impellers are of special totally enclosed, backward flow design. This covered design makes the impellers independent of tolerance variations; the backward flow design gives good pressure, volume and horsepower characteristics.

High strength and long life is assured by all welded, alloy steel impeller construction and pressure lubricated sleeve and thrust bearings. Cast iron casing increases rigidity and decreases noise level.

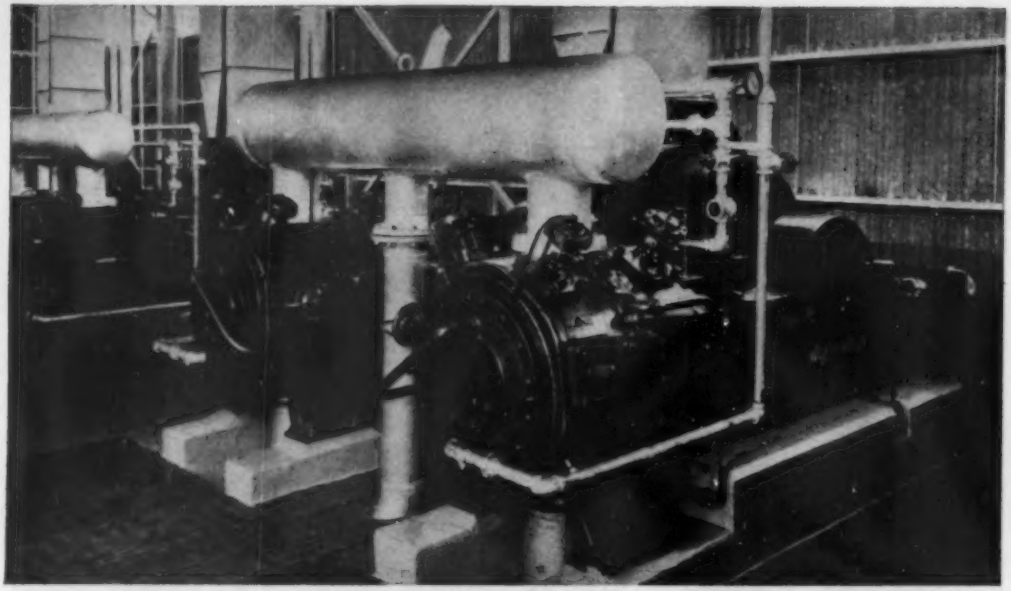
For this kind of specialized design . . . or for standard high quality, thoroughly tested air and gas handling equipment . . . call your nearest A-C office or write direct to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3447

ALLIS-CHALMERS

Texrope is an Allis-Chalmers trademark.

Power, Electrical, Processing Equipment for Petroleum Industry

TURBINE-GENERATORS · BLOWERS and COMPRESSORS · TRANSFORMERS · UNIT SUBSTATIONS · MOTORS—TEXROPE DRIVES-CONTROL · CENTRIFUGAL PUMPS



A New Cracking System at Socony-Vacuum ...BUT THE SAME COMPRESSORS

When Socony-Vacuum needed to modernize its catalytic cracking plant in Buffalo, it put in the thermofor process.

To compress hydrocarbons for the process, Socony-Vacuum selected Worthington DC compressors. Why?

Because—the three Worthington compressors on the old Houdry system performed successfully . . . since 1939.

So . . . in addition to these three, Socony-Vacuum now has four more compressors working on the Thermofor unit. One of these four (not shown in the picture) is a 4-cylinder tandem compressor with a unique control system permitting it to operate on either low or high pressure service.

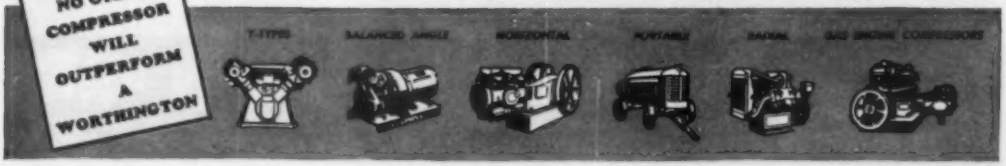
This case illustrates not only the *dependability* of Worthington compressors but also the *adaptability* of the Worthington line to all refinery requirements —all types of gases, all pressures, all capacities. In addition, Worthington provides the broadest line of pumps, engines, refrigeration equipment and other petroleum processing machinery.

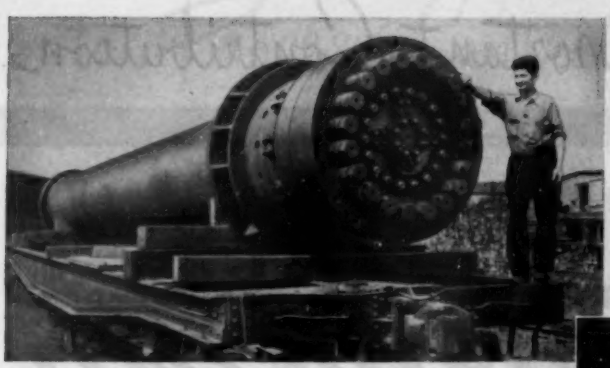
Investigate *more worth in Worthington*. Worthington Pump and Machinery Corporation, Compressor Division, Buffalo, New York.

WORTHINGTON

COMPRESSORS

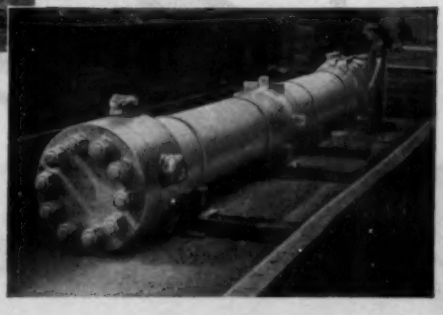
24K1.4





One of several **MULTI-LAYER** Converters designed for 5000 psi working pressure, with corrosion-resistant type 405 alloy inner shell. Wall thickness 8¾ inches, weight 182,000 lb. This type of construction is ideal for high pressure synthesis of coal and shale.

MULTI-LAYER Heat Exchanger designed for 5100 psi working pressure. Wall thickness 4¾ inches, weight 45,800 pounds.

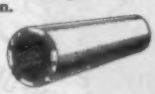


A.O.Smith
MULTI-LAYER
Heat Exchangers & Pressure Vessels

The practical, *economical* solution to your high pressure process and storage requirements

MULTI-LAYER vessels are built-up from concentric layers of relatively thin steel plate, progressively *wrapped, tightened* and *welded* around an inner, pressure-tight cylinder.

Greater range of process possibilities for the planning and design engineer are provided in this unique, patented construction.



Walls can be made stronger merely by increasing strength of steel wrapping plates or by adding more layers.

For corrosive service, only the inner cylinder need be fabricated of alloy or non-ferrous materials.

No size or weight limitations as **MULTI-LAYER** vessels or heat exchangers can be made in any diameter for which satisfactory end closures are available.

The full calculated strength of the steel is more fully utilized in **MULTI-LAYER** vessels. Wrapping tension and weld shrinkage develop compression in the inner layers. This results in more equalized loading of all portions of the vessel wall under working pressure.

Safety is greatly improved by **MULTI-LAYER** construction. Only the inner cylinder need be pressure tight! Outer layers are provided with vent holes which protect the vessel against damage from over-pressure. In the remote event of run-away overload sufficient to cause failure, there is little danger of fragmentation of the vessel wall, due to the nature of **MULTI-LAYER** construction.

Consult A. O. Smith for assistance on your heat-exchanger or pressure-vessel problems. In any event, write for Bulletins V-52 and V-53 for more complete information on **MULTI-LAYER** Pressure Vessels and their construction . . . or use handy coupon.

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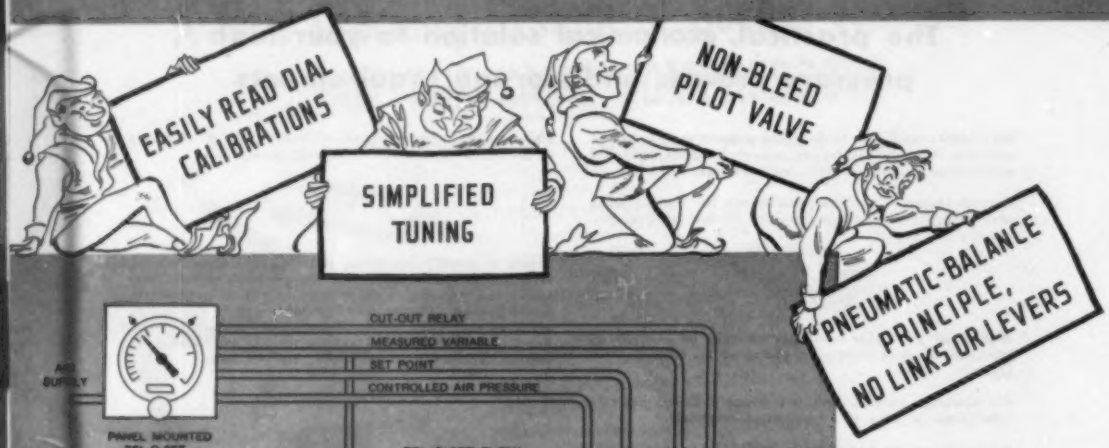
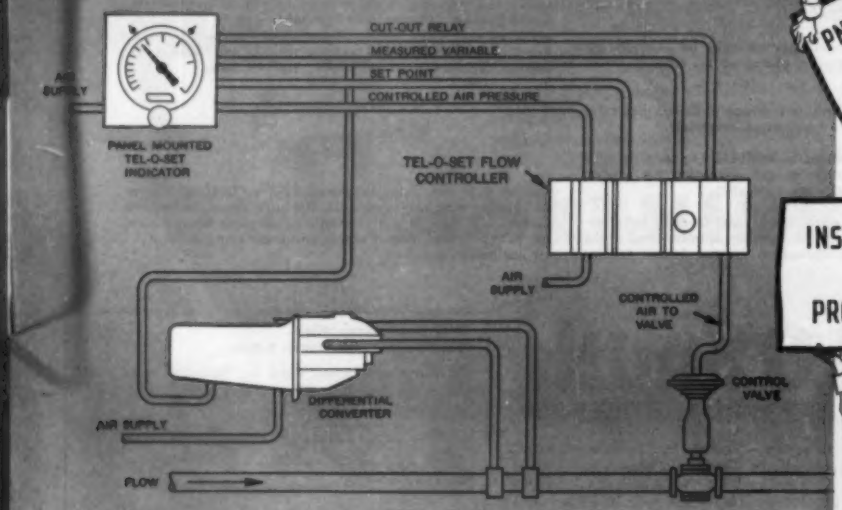
Important Contribution

Introducing...

The New TEL-O-SET CONTROLLERS





ENGINEERED CONTROL SYSTEM FOR FLOW

The Tel-O-Set Controller pictured in this diagram is one unit of the family, each part designed and built as an engineered, integrated loop.

to Process Control

●FOR ALL CONTROL APPLICATIONS—
Flow, temperature, pressure level and other process variables.

●FOR GREATEST ECONOMY IN APPLICATION—
Three control forms available.

●FOR OPTIMUM FLEXIBILITY—
Universal bracket for control room, valve yoke or structure mounting.

●FOR EASY MAINTENANCE—
Coded, interchangeable sections. Split manifold permits removal of controller while on manual by-pass.

For detailed information, write for a copy of Specification Sheet No. 768 . . . and call in our local engineering representative for a discussion of your process needs.

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ALCOA

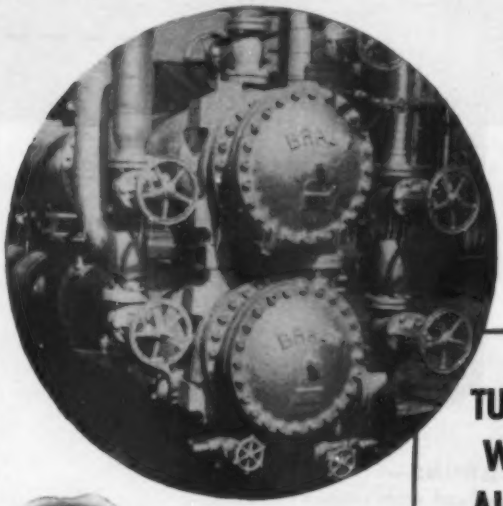
Published by Aluminum Company of America

Rearmament needs severely limit the manufacture of aluminum heat exchanger tubes. But we realize that the purchase of refinery and processing equipment requires long study of economic and performance factors. That is the reason for this message.

ALUMINUM TUBES SAVE THOUSANDS IN COST OF FURFURAL EXCHANGERS

. . . stay free of deposit, cut maintenance and down time

The furfural extraction process for lube oil presents some interesting heat exchanger problems. Copper, acting as a catalyst, polymerizes the furfural. The resulting hard, tenacious deposit requires frequent cleaning.



Then three years ago a large west coast refinery decided to try Alcoa Aluminum Tubes in their furfural exchangers. After several months operation, advantages of aluminum tubes became apparent. ALUMINUM REMAINS COMPLETELY FREE OF FOULING IN FURFURAL SERVICE. Aluminum tubes in furfural service do not require cleaning. In addition to the thousands of dollars saved in original cost, aluminum saves several thousand more each year in reduced maintenance and down time.

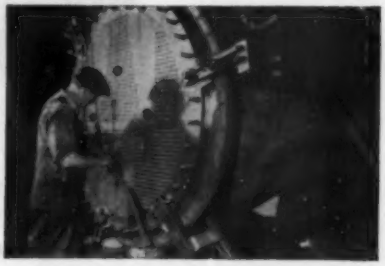
Aluminum tubes are ideal for hundreds of chemical and petroleum applications, and Alclad 3S-H14 tubes are ideal where fresh, salt, or brackish cooling waters are encountered. They are the lowest cost commercial tubes you can buy.

Ask your local Alcoa specialist for more facts and figures to help you in long-range planning.

ALUMINUM COMPANY OFFERS NEW BOOK

This new, 24-page booklet will answer many of your questions about Alcoa Tubes. It covers fabrication techniques . . . alloy selection . . . applications both chemical and petroleum. It describes tube cleaning, the use of inhibitors and methods of cathodic protection. It contains complete information on fluid flow and heat transfer characteristics, plus tables of physical properties and specification data. Write for your free copy today: ALUMINUM COMPANY OF AMERICA 1864J Gulf Bldg., Pittsburgh 19, Pa.

TUBING WITH ALCOA ALUMINUM



Aluminum tube sheets should be used wherever possible. For best corrosion resistance, use Alclad 4S-F Alloy Plate. For high operating pressures, use high tensile strength 61S-T6 Alloy Plate.

Existing commercial practices should be followed for tube hole spacing. Grooved tube holes may afford tighter tube joints, but are not necessary. Standard tools and techniques are used for rolling-in Alcoa Tubes.

The use of steel tube sheets is satisfactory in most fresh cooling waters. If necessary, cathodic protection may be provided in the form of zinc strips or zinc metalizing of the tube sheets.

Complete fabrication, installation and service information is contained in Alcoa's new booklet, "Alcoa Aluminum Heat Exchanger Tubes." Write for your free copy.

Some things to think about

1 Think about experience—over a half-century of it—in serving the Petroleum Industry . . . when you see this name . . .

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2 In processing petroleum and petroleum chemicals, think about product performance—products like Wyandotte Soda Ash—Caustic Soda, Chlorine . . . when you see this name . . .

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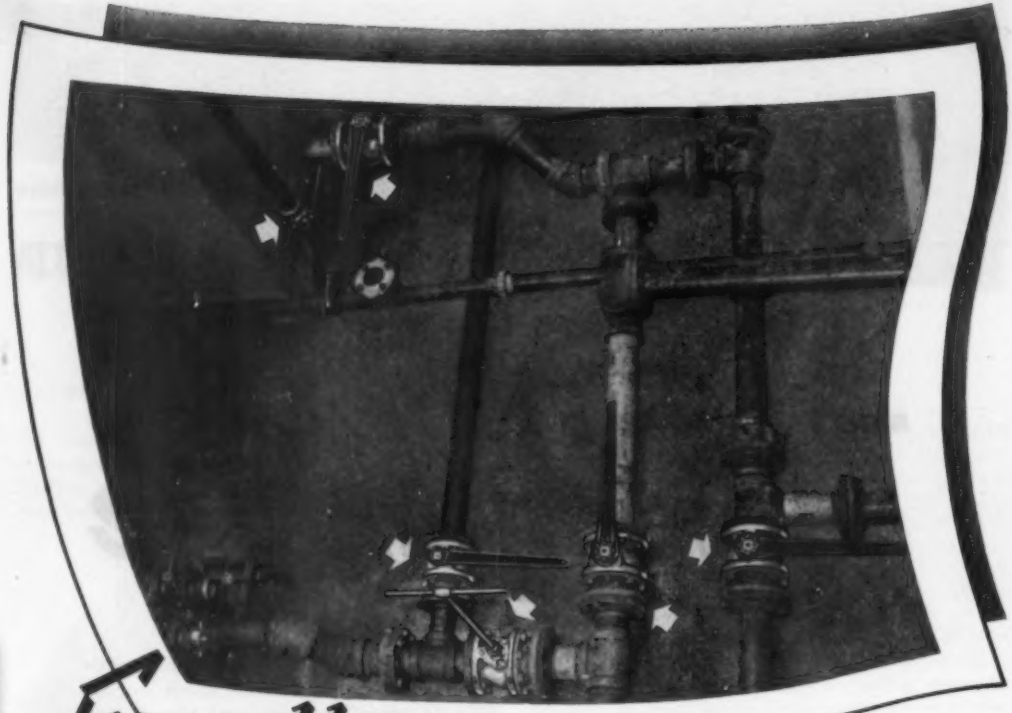

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Wherever a rugged, longer lasting, quick opening and closing valve is needed, Rockwood Ball Valves will fill the bill perfectly. The full *round* flow, leak proof service, and no maintenance features of the Rockwood Ball Valve assures around the clock performance. Rockwood Ball Valves are already giving outstanding service in oil refineries, food, paper, textile, chemical and rubber plants . . . and many more! The group of Rockwood Ball Valves shown above controls the flow of water and various chemicals in a large testing laboratory.

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Seeing is believing — convince yourself by installing Rockwood Ball Valves in your plant, today. Send for folder V-4.

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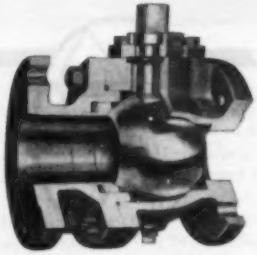
Rockwood Ball Valve made of bronze with screwed ends is available in ½" to 2" pipe sizes. 300 p. s. i. working pressure.



Rockwood Cast Steel Ball Valve available in 3" and 4" pipe sizes. Recommended for refinery, pipe line and general use. 300 W. O. G.

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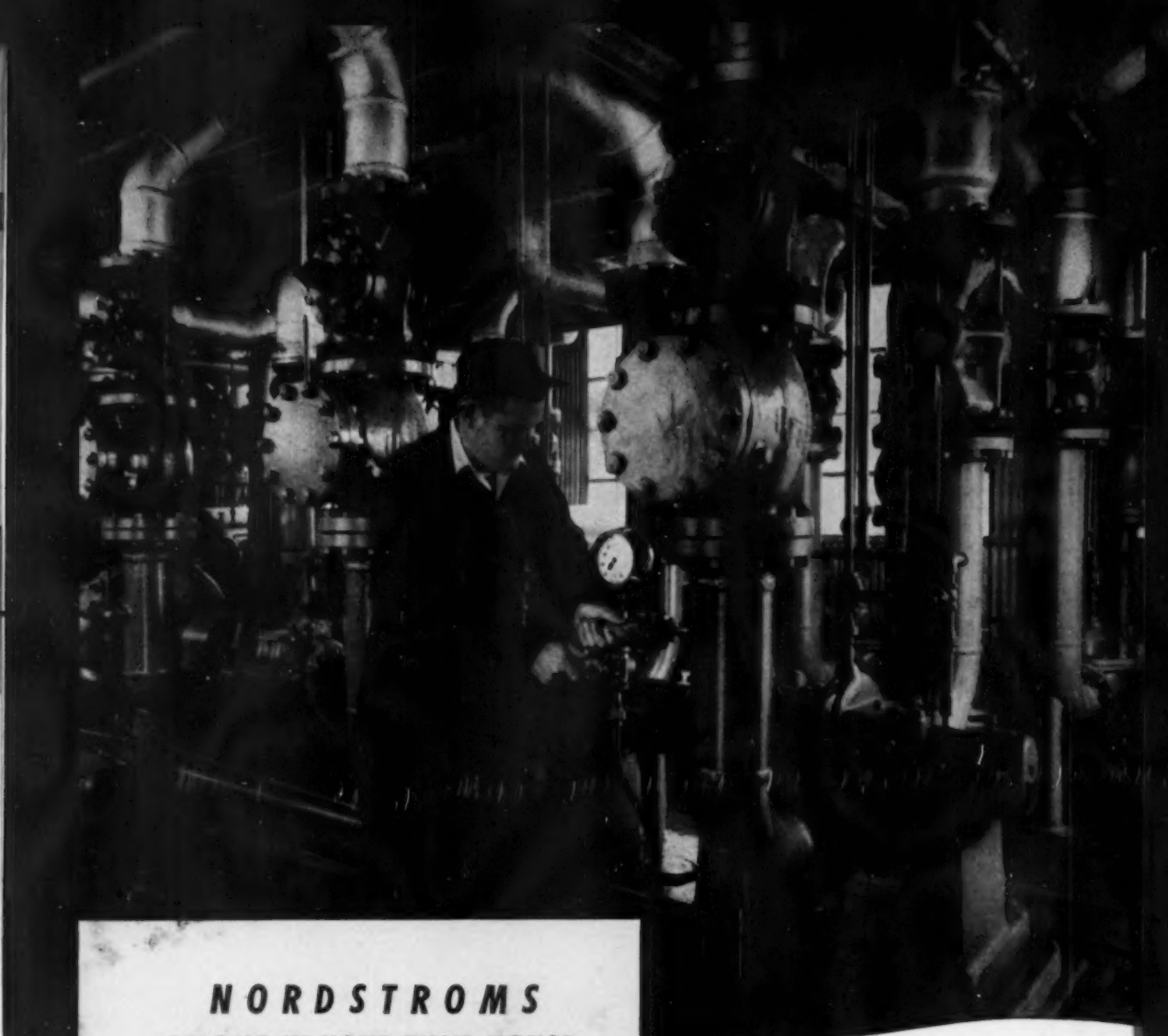

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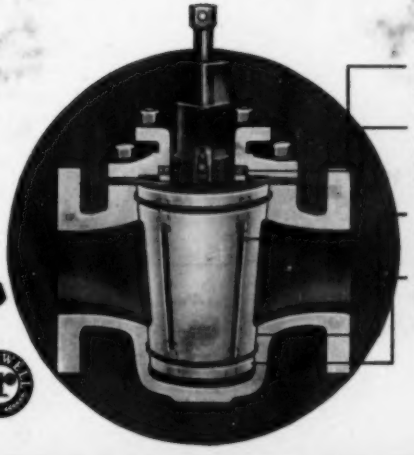

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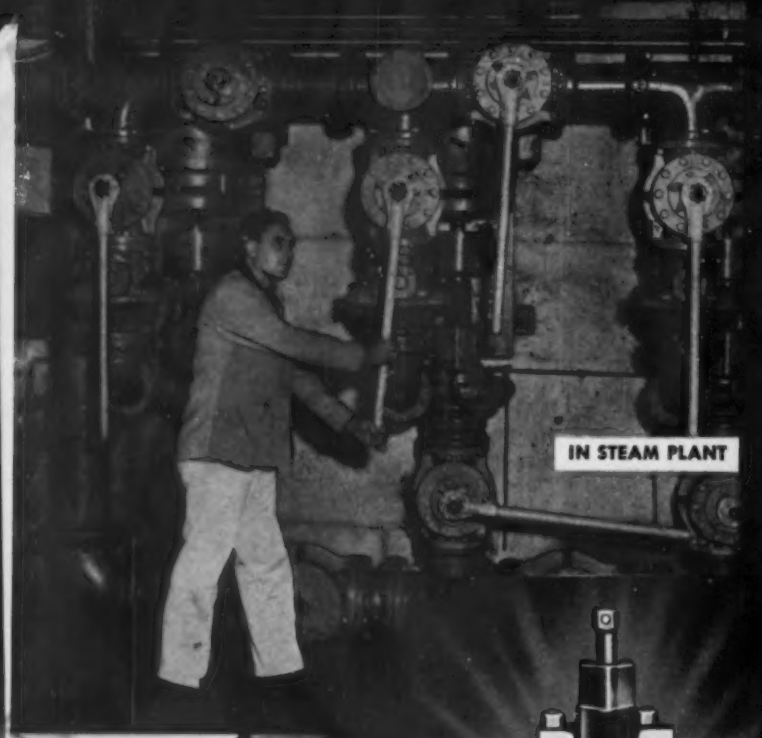

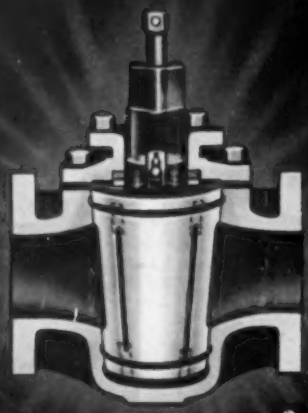

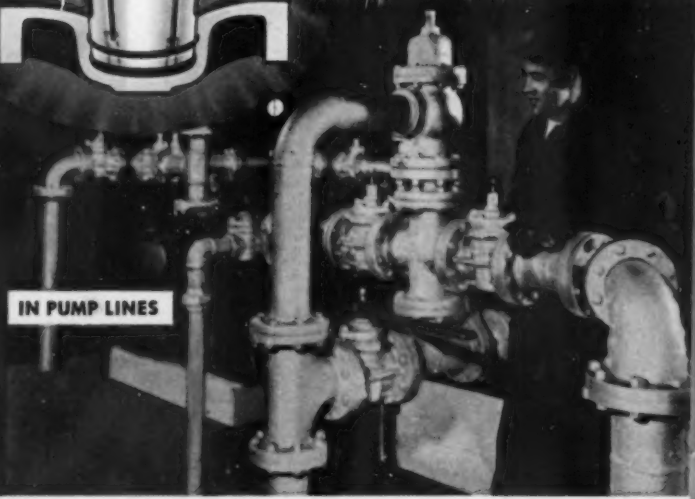

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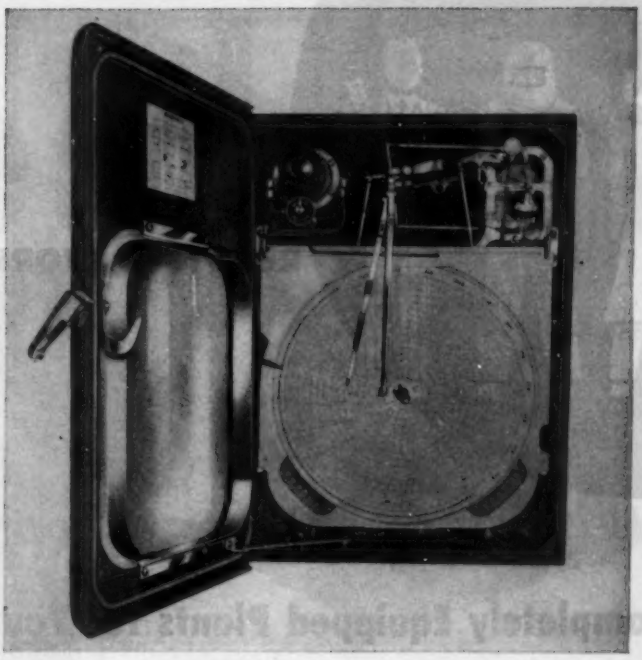
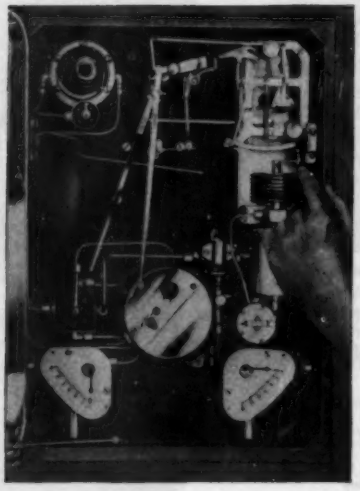


Plant operating men quickly become familiar with it... and like to use it



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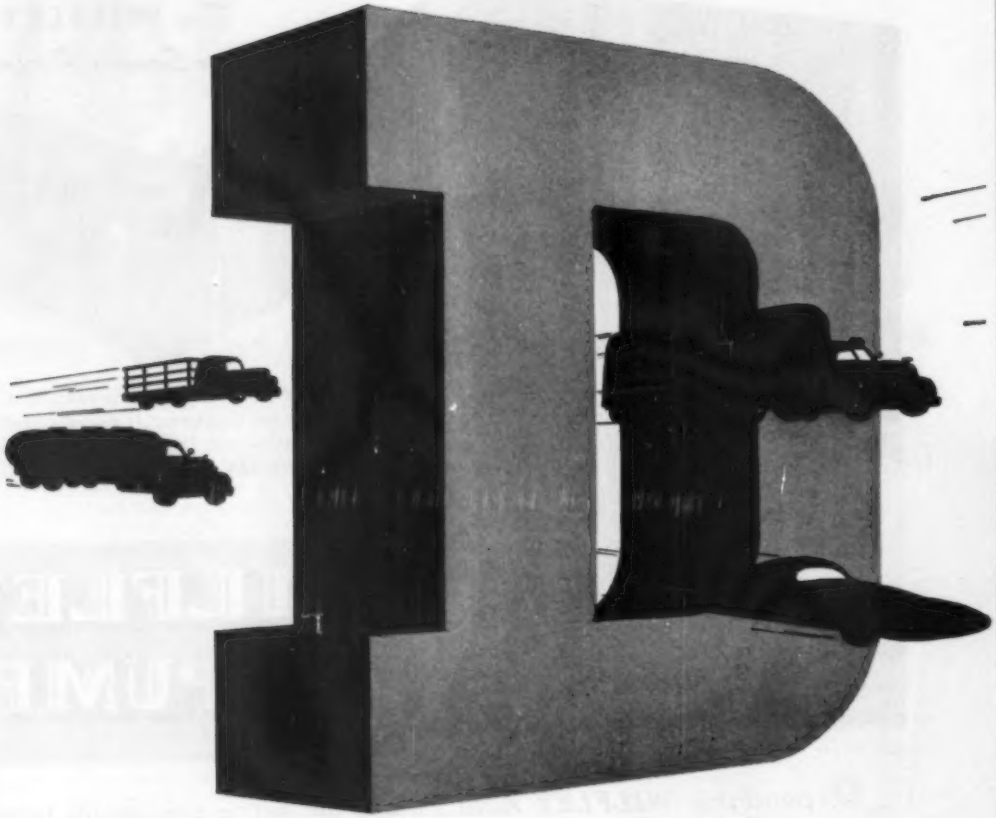

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The operating efficiency of synthetic fluid-type cracking catalysts is important. This operating efficiency can be assured by uniformity of physical characteristics and chemical purity. Davison's production of microspheroidal (M-S*) is tops in uniformity . . . providing all users with a highly efficient synthetic fluid-type cracking catalyst. Your requirements can also be supplied in ground (DA-1*) form. Write for further descriptive information. Experienced Davison Field Service Engineers backed up with complete laboratory testing facilities are part of Davison's service.

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OR 15 years Tennessee Eastman has manufactured the most effective and efficient gum-inhibiting gasoline additives known to the refining industry.

While the name, TENAMENE, is new to the industry, the products themselves are not. Formerly these inhibitors were sold through another company and under that company's name. Today these additives are available directly from the basic manufacturer.

Whether you have been using these Eastman additives under another name or not, you'll find TENAMENE represents the peak in quality and performance. And more than this, you'll enjoy doing business with Tennessee Eastman.

We will be pleased to send you specifications, prices and samples. Write to Tennessee Eastman Company, a division of Eastman Kodak Company, Kingsport, Tennessee, or call our nearest sales representative.

Tenamene

EASTMAN GASOLINE ADDITIVES

TENAMENE 1 (N-butyl p-aminophenol) a gum inhibitor
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Stocks of Tenamene are carried in Ladi, New Jersey; Houston; Los Angeles; San Francisco; and Kingsport, Tennessee.

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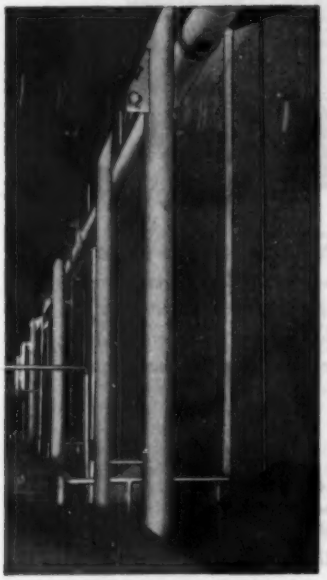
Boiler room of Buffalo State Hospital, Buffalo, N. Y. All boilers, heated equipment, and steam lines are insulated with "Featherweight" 85% Magnesia. Cold water pipes insulated with K&M Duplex.

More than four and one-half miles of steam lines



Partial view of smoke breeching insulated with "Featherweight" 85% Magnesia 3" blocks and finished with Asbestos cement.

OWNER: State of New York
ARCHITECT: Cornelius J. White, State Architect
GENERAL CONTRACTOR: The John W. Cowper Co., Buffalo, N. Y.
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—insulated with "FEATHERWEIGHT"® 85% MAGNESIA

From the new boiler house of the Buffalo State Hospital, 24,000 lineal feet of piping carry steam throughout the institution. And, to guard against heat losses, the entire system—pipes, boilers, smoke breeching, and other heated surfaces—is insulated with "Featherweight" 85% Magnesia.

"Featherweight" 85% Magnesia provides efficient, durable insulation at a cost that insures savings. And the savings are continuous: "Featherweight" will last the life of your heating system!

Keasbey & Mattison "Featherweight" 85% Magnesia Insulation is made in blocks, laggings, and standard-size pipe coverings for all applications up to 600° F. Other K&M Insulations cover service ranges from 40° F. to 1900° F. Our local distributor, who is an experienced applicator, will be glad to give you complete information. Or, write us.

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Twenty-one Model T-1 ALCO Aircoolers with 3 fans per unit, handle all water cooling requirements at each of five pumping stations on the Trans-Arabian Pipe Line.

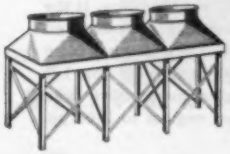
ALCO Aircoolers use Hot Desert Air to Cool Water for Tapline Pumping Stations

Cooling jacket water and lube oil cooling water for engines and generators at the pumping stations of the Trans-Arabian Pipe Line is a real engineering feat. Ground or surface water in expendable quantities is not available and although the ambient temperatures range as high as 122° F., ALCO Aircoolers proved to be the economical answer.

ALCO Aircoolers handle all of the water-cooling needs for Tapline pumping stations except at the terminal—at altitudes up to 2700 feet above sea level —a total of 4770 G.P.M.

Dependability of ALCO Aircoolers was an important factor in their selection for this installation. The remote location of these pumping stations called for rugged equipment which would require a minimum of maintenance attention and withstand the ravages of periodic wind and dust storms.

There is little probability that the conditions in connection with your cooling needs are as severe as this one on the Arabian desert. You can be sure, however, that ALCO Aircoolers can solve your problem, too. Write today for a copy of the ALCO Aircooler booklet or see your nearest ALCO Sales Engineer at Chicago, Dunkirk, Houston, Kansas City, Los Angeles, New York or Tulsa. Plants: Dunkirk, New York and Beaumont, Texas.



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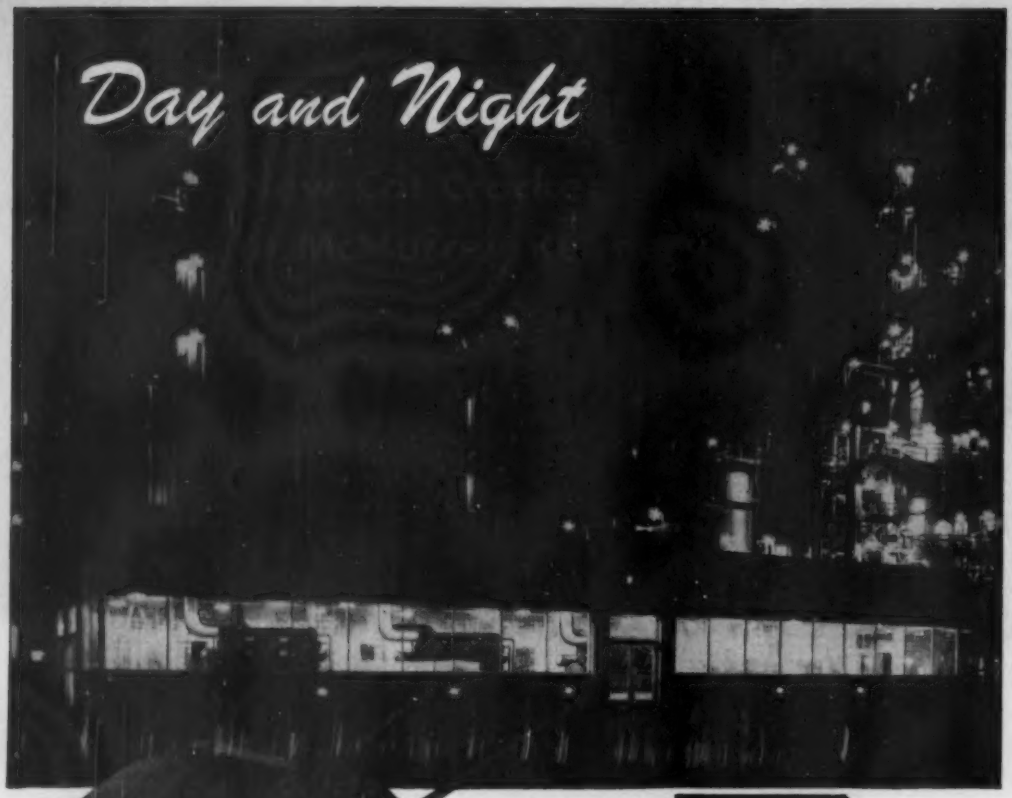

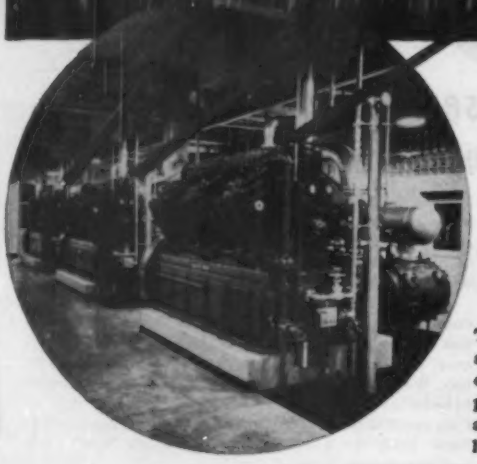

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Gas-Engine-Driven COMPRESSORS for Gas Concentration

The new U.O.P. fluid catalytic cracking unit recently installed at the McMurrey Refinery, Tyler, Texas, gives this progressive oil company an added capacity of 4000 barrels of charge stock per day. To assure uninterrupted service, night and day, year after year, every item of associated equipment has to meet the highest standards of dependability, performance and economy.

The gas-concentration compressors selected for this important job are three Ingersoll-Rand Type SVG gas-engine-driven units. The SVG, also built in 440-hp size, is the new machine that is essentially a modernized version of the famous XVG. Let us tell you more about the SVG, and other sizes in the I-R 4-cycle line . . . gas engine compressors from 110 hp to 1320 hp . . . gas engines to 1760 hp.

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The workman of ancient Egypt knew the symbols of his trade. They helped him fashion stone and metal, wood and cloth, into the goods and structures which best served his era. . . . The needs of our modern industrial civilization are different. Visitors to Sun Ship's mighty shops see in the making the intricate steel fabric of petroleum refineries and chemical plants . . . massive bubble towers, pressure vessels, condensers, cracking cases, and a vast array of special machinery and equipment for many industries.

But even a visitor from the days of Egypt's Pharaohs would recognize two familiar facts — that strange modern "hieroglyphics" guide precise assembly of today's steel behemoths . . . and that Sun Ship workers are masters in their knowledge of the symbols and crafts of their trades. . . . The many modern industries served by Sun know these facts, too.

Illustration at top, reproduced from "The History of All Nations," shows ancient Egyptian shipbuilding as depicted on the tomb of Ti, at Sakkara. In contrast is the 55' regenerator being built by Sun.

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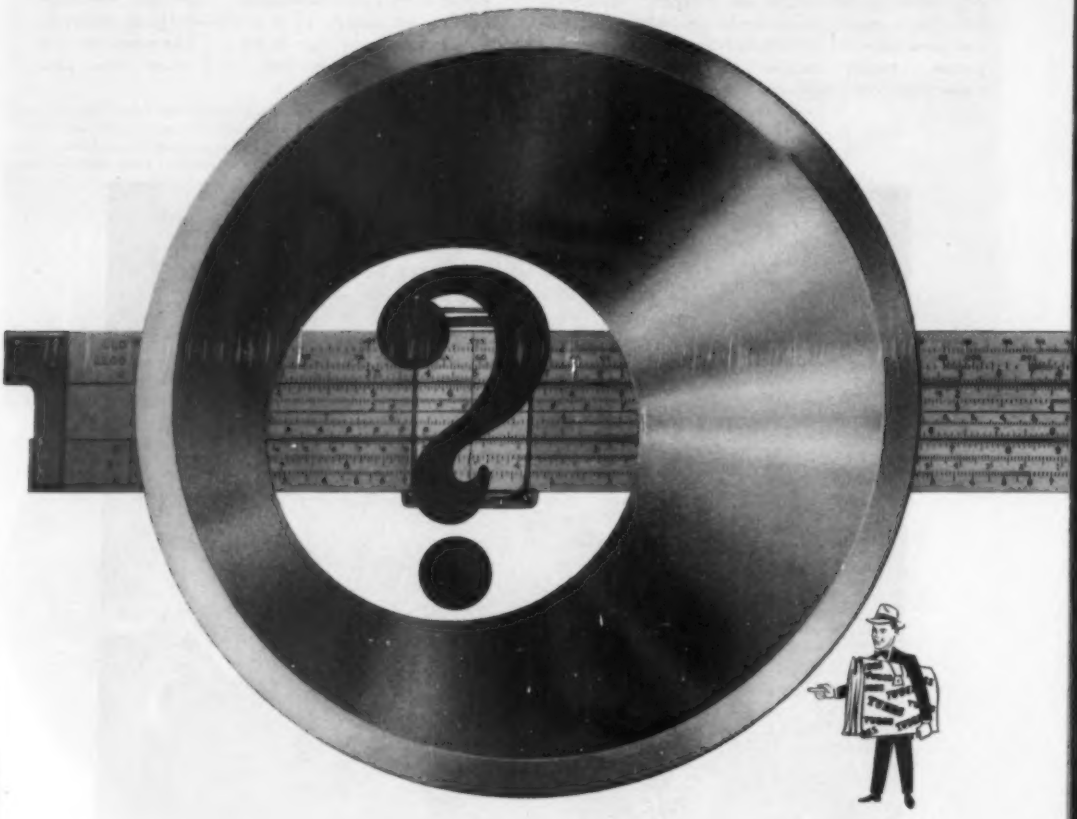

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for long-term exposure at 650F. to 850F.

take a **CLOSER LOOK** *at*

mechanical properties

In apparatus where tubing must withstand high internal pressures at elevated temperatures, *mechanical properties* of the tubing-steel are important determinants of wall-thickness and size.

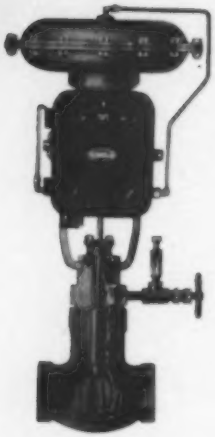
Evidently, any lasting improvement in the physical properties of a given steel will allow the designer a greater latitude in the selection of tubing, with possible advantages in the reduction of weight and cost.

Croloys 2¼, 5, and 7 have long been popular in the fully annealed state for normal service conditions up to 1250 F. Now it is established by recent B&W tests that the *increased* mechanical strength obtained by normalizing and tempering these alloys is substantially unaffected by long-term exposure to temperatures up to 650 F.; and that Croloys 5 and 7 maintain these improved properties even at temperatures up to 850 F.

Complete details of the tests are covered by Alloy Letter No. 265, available on request.

B&W SEAMLESS and WELDED TUBES

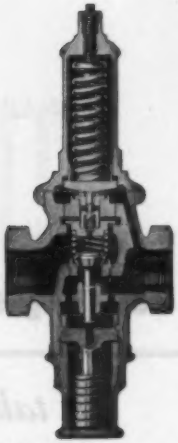
TA-1606-5



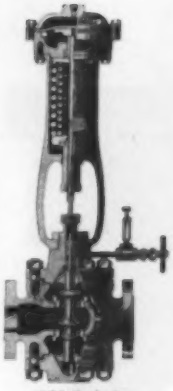
#2707-137-S
Pressure Controller (3000# W.P.)
Spring Opened
(#138-S Spring Closed Available)

#138-2 Control Valve w/positioner & airset air-to-open
(#137-2 air-to-close available)

#137-2 Control Valve
Percentage Parabolic Trim
(#137-3 V-Port available)



#11 Steam Reducing
(5-225# Outlet)



#35 Reducing
#36 Back Pressure

#12600 Series Liquid Level Controllers, Torque Tube Type (No Packing)

MASONEILAN REGULATORS

For Gas, Air, Steam, Water or Oil Service

See "MAINTENANCE" about your Control Problems

Our application engineers will understand your needs and recommend most suitable regulator for the job.

IMMEDIATE SHIPMENT of

Regulators
Liquid Level Controllers
Diaphragm Control Valves
Parts

from LARGE HOUSTON STOCKS

MAINTENANCE
ENGINEERING CORPORATION
3617 CLINTON DRIVE
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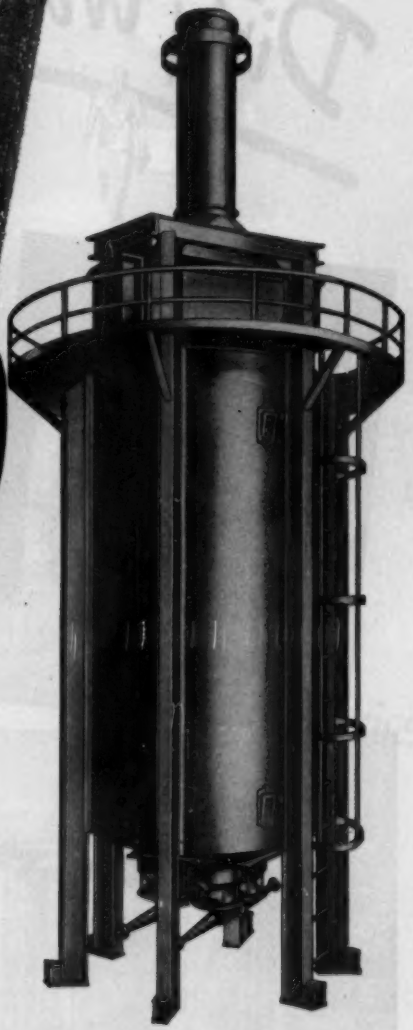
HOUSTON 1, TEXAS
EQUIPMENT WITH ENGINEERING SERVICE
MECO

★ **For Direct Heating of Liquids and Vapors**

★ **Indirect Heating Systems Using Circulating Medium**

Struthers Wells

for the Process Industries



A complete line of direct fired heaters is available in standard sizes from 100,000 to 25,000,000 BTU per hour. These units are in wide use in services such as heating gasoline, oils or asphalts, superheating steam or gas, and for indirect heating systems. The heaters are shipped shop assembled except for the largest sizes.

Struthers Wells indirect heating systems, utilizing either a vapor or liquid heat transfer medium, such as Dowtherm, are giving economical and trouble free operation at temperatures to 750° F., or above this.

Equipment is ordinarily supplied with instruments and safety controls to give a complete installation. Large installations in service for many years testify to the correct design and quality of this equipment.

If your process requires temperatures above those of existing steam supply, if steam is not readily available, or if the process can be improved by higher temperatures, this economical and simple equipment will be of interest. We can also supply smaller equipment, electrically heated, as package units.

Write on your letterhead for our new Bulletin B-45, describing a complete line of equipment for high temperature process heating.

Struthers Wells

STRUTHERS WELLS CORPORATION

Warren, Pa.

PLANTS AT WARREN, PA. • TITUSVILLE, PA.

Offices in Principal Cities

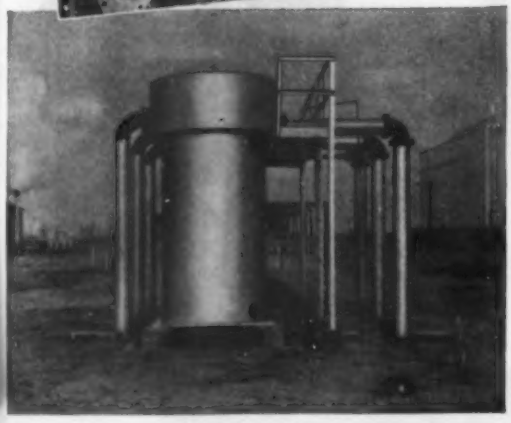
Dirty Water can't "Shut-down"...

Vogt

film type exchangers

(Condensers—Coolers—Evaporators)

Patent Nos. 1,935,270 - 2,057,597 - 2,424,441



River water, well water or brackish water are all alike to this exchanger *because it can be cleaned* while in operation! The water distributing ferrules need only be removed successively for the cleaning brush or tool whereby the tubes receive additional water which sluices away the dislodged dirt.

Vogt Film Type Exchangers are operating with real economy of first cost, operation and maintenance in power, petroleum, and chemical industries. They serve as Jacket Water Coolers, Feed Water Heaters, Hydrocarbon Evaporators, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to cool or heat any liquid and to condense or evaporate any fluid.

TOP: *Four units at Newton Falls, Ohio Municipal plant cool water for diesel engines and a lubricating oil cooler.*

BOTTOM: *Jacket Water Coolers serving engines of 7,500 HP in the compression plant of a Western Oil Refinery.*

[Bulletin HE-7 describes typical installations of Vogt Film Type exchangers and is available upon request.]

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

SERVICE LEDGER
1901-1951

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ARGENTINE MINISTRY OF WAR
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CANADIAN OIL REFINERIES, LTD.
CALIFORNIA REFINING CO.
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CIE. FRANCAISE DE RAFFINAGE
CIE. INDUSTRIELLE DES PETROLES
CITIES SERVICE OIL CO.
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IMPERIAL CHEMICAL INDUSTRIES
IMPERIAL OIL LTD.
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UNION OIL CO. OF CALIFORNIA
UTAH OIL REFINING CO.
WASATCH OIL CO.
WOOD RIVER OIL & REFINING CO.

Pacing Refining Progress ...in Latin America!

Kellogg's association with Latin America dates back to the Twenties, when Kellogg was fabricating shell stills for refiners all over the world. These early contracts led to the design and construction of many key sections of the original refinery at Aruba. In subsequent years, as this refinery was continually modernized, Kellogg installed thermal cracking and hydrogenation units and also Latin America's first Fluid catalytic cracker.

Today finds Kellogg active further South. Within the year, the company has put on stream Brazil's first complete cracking refinery . . . started an expansion to double its capacity, also adding cat poly and LPG facilities . . . and initiated work on a 10,000 BPD complete refinery at Rio de Janeiro.

Concurrently, in the Argentine, Kellogg has placed a complete toluene plant on stream at Campana and started construction on a 30,000 BPD refinery at La Plata. This project includes the most advanced high-octane processes—Fluid catalytic cracking, catalytic polymerization, and alkylation—as well as topping, vacuum flashing and delayed coking.

THE M. W. KELLOGG COMPANY

A SUBSIDIARY OF PULLMAN INCORPORATED

for fifty years an integral part of processing history

NEW YORK · JERSEY CITY · LOS ANGELES · TULSA · HOUSTON · TORONTO · LONDON · PARIS

KELLOGG FOR YOU 37th Anniversary

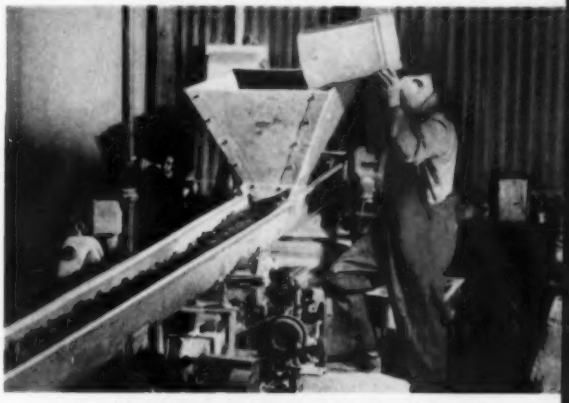
Portrait at

This year is Kellogg's fiftieth of service to industry. At this time naturally, as a group of men—known collectively to the modern business world as The M. W. Kellogg Company—we can think back nostalgically. We can remember the chimney stacks

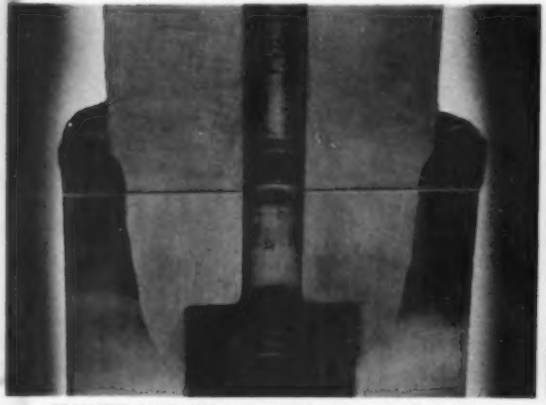
Meeting the Toughest "Specs"...

In previous issues of this magazine, camera "portraits" of M. W. Kellogg today have highlighted the major aspects of Kellogg's broad research, development, engineering and procurement activities.

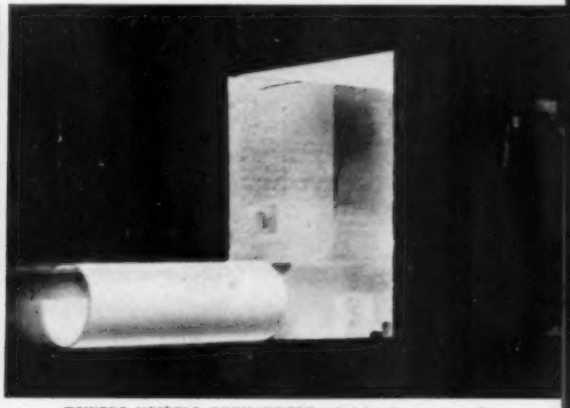
This month, Kellogg's manufacturing operations, largely centered in Jersey City, New Jersey, come within the lens. Some of these operations are continuations of various phases of the original metal fabricating business from which the modern company stemmed. Others had their inception as outgrowths of Kellogg's research and development activities... when the company undertook the manufacture of new equipment and materials which were not commercially available but which were required to meet improved engineering specifications.



1. ***WILLINGNESS TO PRODUCE SPECIALTY ITEMS*** is readily apparent in this catalyst manufacturing phase of the company's operations. When cat poly and hydroforming were being introduced into commercial refining, there was no readily available source for the special catalysts desired. Consequently, Kellogg undertook their manufacture and, today, two plants in Jersey City continue to produce these specialized materials.



4. ***FROM THE SAME MILL*** came a special transition piece (test piece illustrated) which solved a problem in the design of 1050°F power piping installations. The piece is used to join two types of alloy piping with widely varying coefficients of thermal expansion. It is so cast that the analysis of each end matches that of the piping to which it is joined. The result: elimination of excessive weld stress at elevated temperatures.



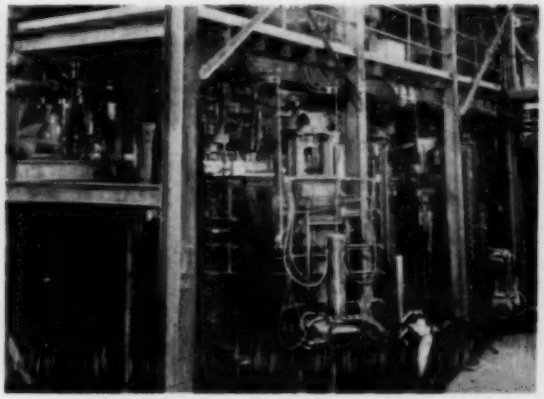
5. ***TOWERS, VESSELS, EXCHANGERS*** and piping, however, are the principal products of the shops. Facilities are complete, from plate forming to precision machining. The shops are employed in three major ways . . . to build prototypes of Kellogg-developed equipment; as a prime supplier on refinery construction contracts; and to manufacture custom-made equipment for direct sale to the process industries.

Fifty... no 8

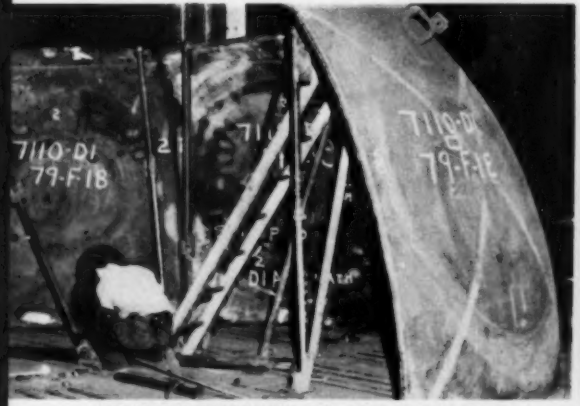
KELLOGG
1901-1951
50th Anniversary

we built in 1901 . . . the first crude vessels for oil refiners in the 'teens . . . our first combination unit. The forty-odd Fluid cat crackers built in these years. But, after all, The M. W. Kellogg Company is only a factor as it is able to serve industry today. For that reason, we are presenting this series of monthly camera studies which document our belief that a truly integrated organization can better serve industry to achieve greater earning power. This is No. 8 in the series.

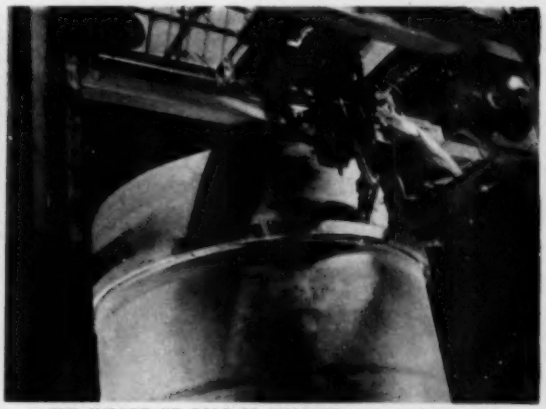
2. ***A SIMILAR SITUATION*** placed Kellogg in the refractories and refractory products business. These products play so large a part in most industrial processing projects that years ago the company developed materials specifically suited for process plant applications. Currently, these materials are made to Kellogg specifications and sold under such trade names as Ignisite, Kel-crete, Kel-block and Thur-Ma-Lox.



3. ***PROBABLY THE LAST THING*** you would expect to find at Kellogg would be a steel mill. Yet, this unique electric steel plant at Jersey City, outgrowth of Kellogg metallurgical research, is continuously producing alloy ingots with exceptional mechanical properties. The process assures a constant analysis throughout the cross-section of the ingot which explains why jet turbine manufacturers are steady customers for this steel.



6. ***LARGE PROCESS VESSELS*** call for different techniques because it is frequently impossible to ship them completely assembled over inland rail routes. Kellogg has developed two solutions to this problem. First by floating vessels to their final locations over inland waterways. Second, and more recently, by knockdown fabrication of carefully matched segments in the shop as shown in the accompanying picture.

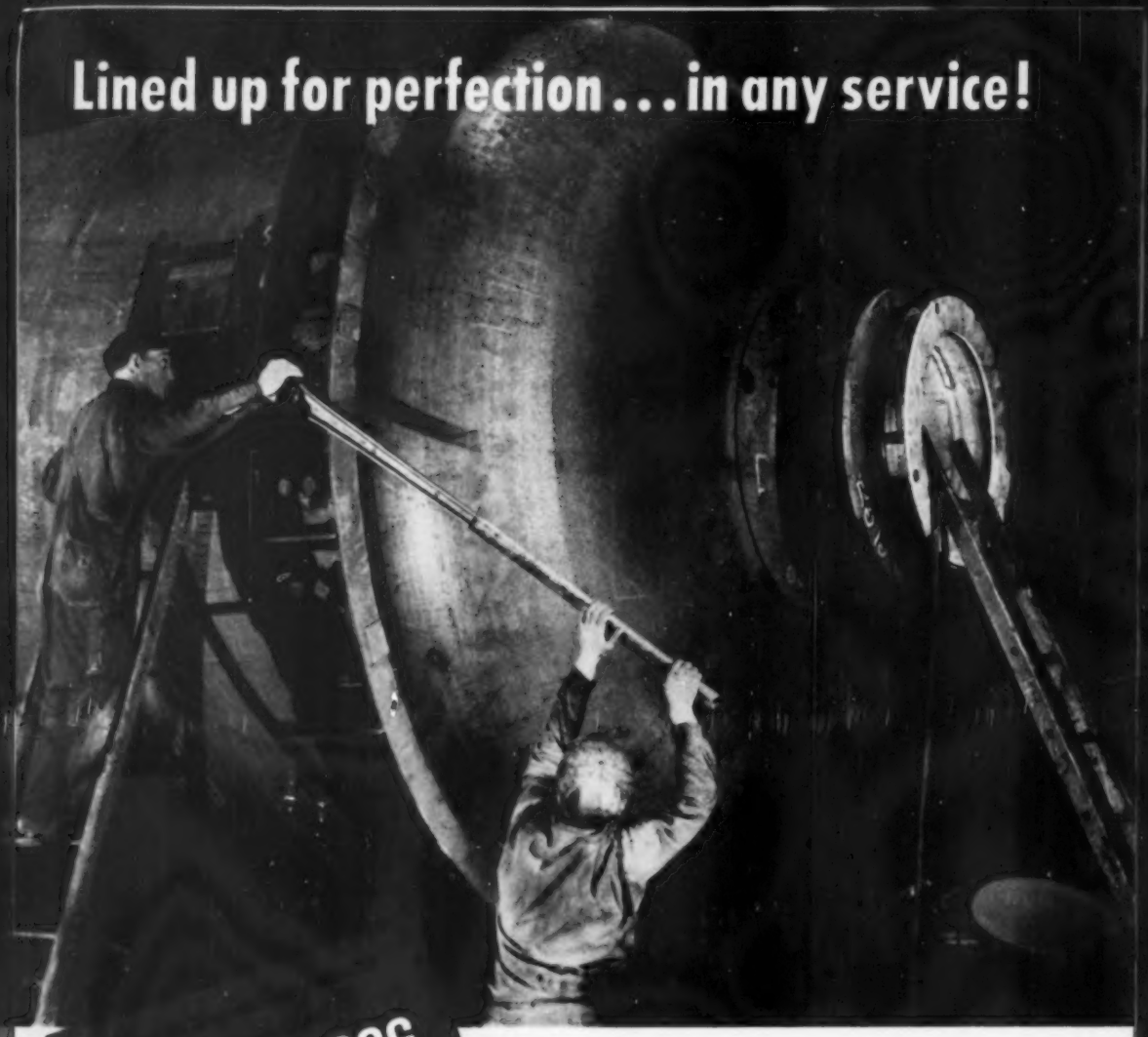


7. ***THE IMPORTANT ROLE OF WELDING*** in the fabrication of equipment is underlined by the fact that the company maintains a special *Welding and Welding Practices Research Group*. Since 1931, this group has been closely associated with such developments as continuous welding, inert gas welding and other techniques with the result that today Kellogg's equipment is among the most modern available.

NEXT MONTH

. . . in the ninth of this series of camera studies of M. W. Kellogg today . . . you will glimpse a few of the specialized, and in many instances unique, techniques employed to improve the quality of manufactured products.

Lined up for perfection . . . in any service!



M. W. KELLOGG

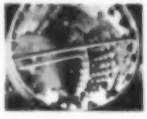
In digestors for pulp mills . . . special towers for fatty acid splitters . . . refinery vessels, large and small . . . in equipment for any processing task, Kellogg's accurate line-up techniques, preparatory to welding, pay off in peak operating performance and longer service life.

Pressure Vessels
Vacuum Vessels
Fractionating Columns
Drums and Shells
Heat Exchangers
Process Piping
Hi-pressure—Hi-temp Power Piping
Bends and Headers
Giant One-Piece Bends
Forged and Welded Fittings
Radial Brick Chimneys

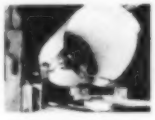
Continuing Study of behavior of metals under stress at high temperatures has produced valuable design data.

Shop Layout Craftsmen are fully experienced in vessel fabrication from nozzle positioning to "knockdown" fabrication for field assembly.

Extensive Facilities from forming of plate to final machining of precision surfaces permit complete fabrication under the same roof.



Special Welding Techniques and stress relieving methods assure equipment performance even under severest operating conditions.



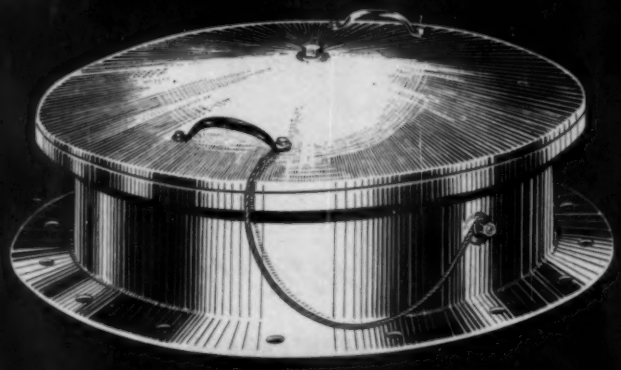
Rigid Quality Control, devised by specialists, including chemical and micro analyses as well as mechanical and non-destructive testing.

NEWS FOR OPERATORS IN WESTERN CANADA!

The Canadian Kellogg Company Ltd. has established complete shop facilities for the fabrication of all types of piping at **EDMONTON**, Alberta. Inquire directly or through any Kellogg or Canadian Kellogg office.

The M. W. Kellogg Company *(A Subsidiary of Pullman Incorporated)* **New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris**

Solves Emergency Venting Relief —



THIS Shand & Jurs 20" Emergency Vent has been designed for mounting right on a 20" A.P.I. Standard manhole. Without any additional modification of a tank, the vent can be mounted and put into operation immediately. It is presented to meet a long-standing need in the Petroleum Industry for an emergency relief vent which will take care of most emergency venting necessities arising due to air surges, excessive or unusual pumping, or thermal conditions. It is not, however, intended for explosion relief.

Designated Fig. ST-5455, this Emergency Vent is automatically self-sealing. The cast aluminum pallet, which is also the manhole cover, provides a standard loading of 2½" water pressure. The sturdy steel base ring, which forms the seat for the pallet, has a hard stainless facing of Hastelloy B to resist corrosion, and is designed to resist mis-shaping, should the manhole flange be distorted or warped. To comply with Flammable Liquids Code requirements of many states, a safety cable is provided to fasten the free lifting cover to the tank. Special materials and loadings are available on specification.

S&J

Shand and Jurs Co. 8TH AND CARLTON STREETS : BERKELEY : CALIFORNIA

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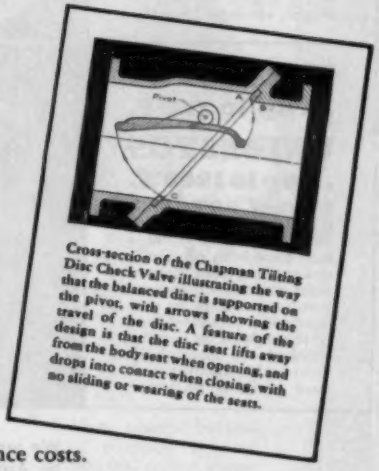
Announcing
the formation of
C R C
ENGINEERING COMPANY
A new organization to provide complete engineering design services for crude, gas and products pipe lines, including economic studies of proposed projects.
With experience records in engineering design and construction of pipe lines for more than twenty years, the principals in C-R-C Engineering Company have contributed to the design and construction of many of the major pipe line systems now in operation.
The partners in this joint venture are H. E. (Herb) Fisher, A. S. Crutcher, Gene Rolfe and Jim Cummings. Fisher has been associated with the engineering design and construction of pipe lines for 20 years and recently resigned as Chief Engineer of the Standard Oil Co. (Ind.) Pipe Line Department. The other members of the new firm . . . Crutcher, Rolfe and Cummings . . . have been leaders for nearly twenty years in developing, manufacturing and supplying the pipe line industry with the principle work equipment now in use throughout the world.
CONSULT US ON YOUR PIPE LINE PROBLEMS. OUR EXPERIENCE AND "KNOW-HOW" GUARANTEES A THOROUGHLY ENGINEERED PIPE LINE SYSTEM WHICH WILL OPERATE AT MINIMUM COST.
Gene Rolfe
Jim Cummings
C-R-C ENGINEERING COMPANY
COMPLETE ENGINEERING DESIGN SERVICES
Crude — Gas — Products
Pipe Lines
7825 Katy Road, Phone VIctor 6391, Houston, Texas

CHAPMAN

TILTING DISC CHECK VALVES

Cut Maintenance Costs

with Cushioned-Closing



Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

There's less wear on seating surfaces, hinge pins and bearings with the cushioned closing action in a Chapman Tilting Disc Check Valve. No destructive slamming. No fatiguing flutter. No vibration of pipe lines or adjacent structure — nor danger of opening pipe joints or rupturing pipe lines. Just a quick and quiet closure that cuts maintenance costs.

And what's more, the balanced streamlined discs in Chapman Tilting Disc Check Valves ride smoothly on the stream—reduce head losses 65 to 80% over conventional swing type checks. You'll want to know more about this maintenance-saving, more efficient check valve. Write today for engineering data, Bulletin #30.

THE CHAPMAN VALVE MANUFACTURING COMPANY
INDIAN ORCHARD, MASSACHUSETTS

NOW 3 GREAT PIPE INSULATIONS

Amocel

joins Unibestos in the UNARCO line of asbestos pipe insulations

...up to 650°F.

Answering the demand for a jacketed pipe insulation for use in the lower heat ranges, UNARCO now offers Amocel — for temperatures up to 650°F. Like Unibestos, Amocel is made of Amosite asbestos fibers bonded with an inorganic binder. For pipe sizes from ½" through 12", in Standard thickness only. Light in weight. Highly efficient. Durable.

UNIBESTOS
...up to 750°F.

UNIBESTOS
...up to 1200°F.

2 GREAT PIPE INSULATIONS — Unibestos No. 750 and No. 1200 — long have been America's outstanding insulations in their respective temperature ranges. Regular production for pipe sizes from ½" through 24" in popular thicknesses through 4". Other thicknesses and sizes available on order.

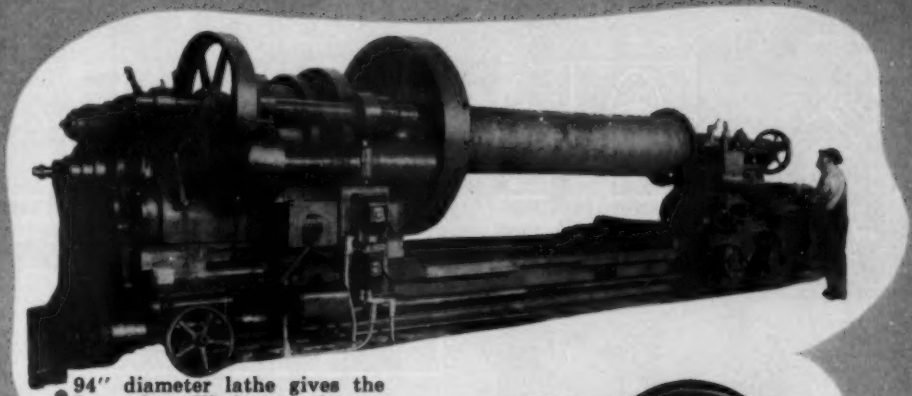
We want you to have our Catalog — It gives you complete information on Amocel and Unibestos Pipe Insulations; Unibestos Insulating Block; Cements and Finishes; Flexible Insulations; Metal Mesh Blankets; Tailored-to-Fit Insulations; Asbestos Packings and Gaskets; Asbestos Textile Products . . . Just drop us a line today requesting that we send you UNARCO Catalog No. 76-109.

UNARCO

UNION ASBESTOS & RUBBER COMPANY

DEPT. 1823 • 332 SOUTH MICHIGAN AVENUE • CHICAGO 4, ILLINOIS

for Your Share of that Extra
75,000 BBLS. PER DAY



● 94" diameter lathe gives the Posey Iron Works an edge on large jobs requiring lathework

Crude-oil input capacity of United States refineries is currently scheduled for an increase of 75,000 barrels per day. That means expansion of storage facilities to keep pace with production equipment now being installed.

For decades, Posey Iron has served the refinery industry with storage equipment especially designed to meet the requirements of the petroleum and L-P gas fields. Posey Iron engineering is based on a *practical* knowledge of the industry . . . the sort of "shirt-sleeves" knowledge that eliminates needless tardiness in delivery . . . needless increase in cost. Consult Posey about your storage requirements.

PRESSURE VESSELS FRACTIONATING TOWERS
ELEVATED TANKS STORAGE TANKS
LARGE DIAMETER FABRICATED PIPING
GENERAL STEEL PLATE CONSTRUCTION

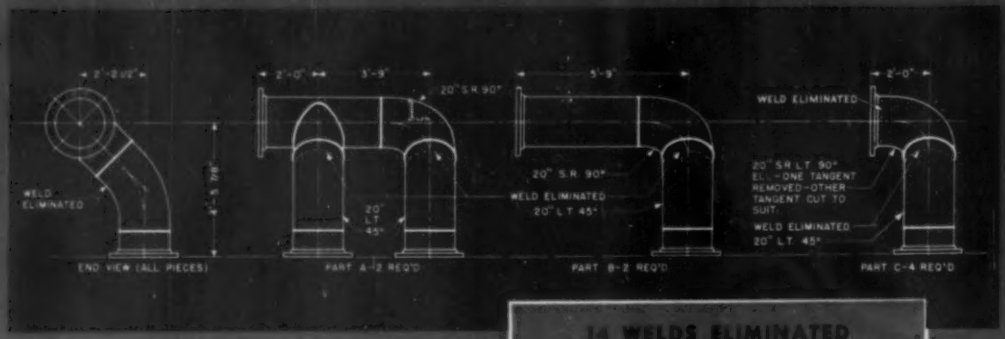
● View shows bottom of recently erected 200,000 gallon Posey Iron Elevated Tank.

POSEY IRON WORKS, INC.

Steel Plate Division • Lancaster, Pa.
New York Office: Graybar Building

DIVISIONS: BRICK MACHINERY . . . INDUSTRIAL HEATING . . . IROQUOIS . . . SHIPBUILDING . . . STEEL PLATE.

12% COST REDUCTION... *in these piping subassemblies*



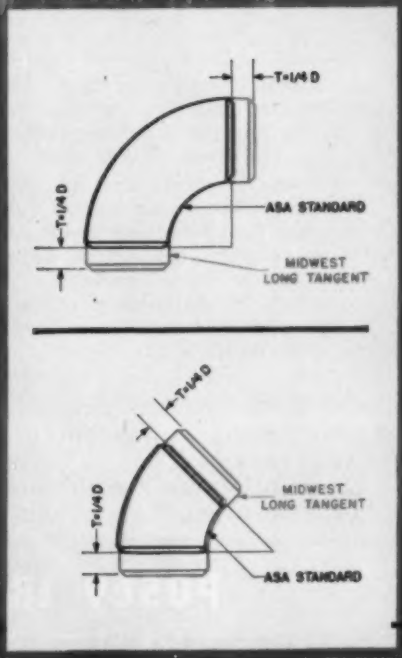
14 WELDS ELIMINATED
9'-8" OF 20" PIPE SAVED

with MIDWEST "LONG TANGENT" ELBOWS

Here is a concrete example of the extra cash value of Midwest "Long Tangent" Elbows. They saved 12% of the cost of this piping.

Each of the subassemblies shown above, if made of ASA elbows, would have required an extra nipple with an extra weld at the dotted line. With the Midwest Long Tangents, both the nipples and the welds were eliminated. Reduced material and labor costs made this substantial saving.

Other advantages of Midwest "Long Tangent" Elbows: pipe and fitting lined up more quickly and accurately, weld is removed from point of maximum bending stress, can be sleeved, slip-on welding flanges are more easily used, and they cost no more than standard elbows usually furnished. Ask for Catalog 48.



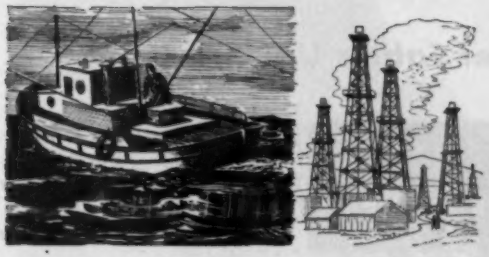
MIDWEST WELDING FITTINGS
Improve Piping Designs and Reduce Costs

MIDWEST PIPING & SUPPLY COMPANY, INC.
Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Pascola, Los Angeles and Boston • Sales Offices: New York 7—30 Church St. • Chicago 3—79 West Monroe St. Los Angeles 33—830 Anderson St. • Houston 2—1213 Capitol Ave. • Tulsa 3—234 Wright Bldg. • Boston 27—436 First St.

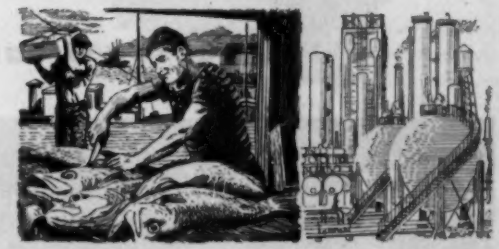
"What's this 'integration' they're attacking you for?"

One of the complaints *now made about big companies like Standard Oil Company of California is that they practice "integration". This word is made to sound so evil that you may wonder what it means as it's used in this case.*

The fact is that integration is common in American businesses both large and small. They use it as a natural part of their system of increasing efficiency, cutting costs and improving products. Integration doesn't make a *good* company *bad*. To understand integration at a glance, look at this parallel:

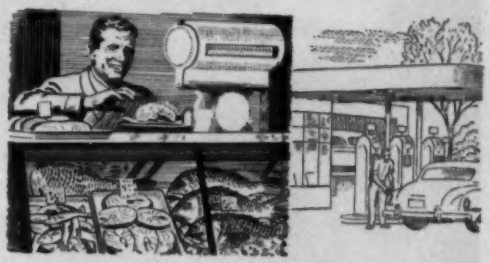


A fisherman takes his boat onto the ocean and makes his catch. Standard discovers oil and brings it up out of the ground. If both then *sell*—the fisherman to a buyer at wharfside, and Standard to some buyer at the well—there's no integration. But suppose each takes the next step...



When the fisherman cleans his own fish, he has become an integrated business. So, too, Standard. Like him, we work to put the product into the form you want. We refine the crude oil we ourselves produce—turn it into gasoline, lubricants, chemicals, and all the rest. This is integration.

If the fisherman now carries his cleaned catch to the market-place, he is further integrated, for he is now also in the transportation business... as is Standard when we operate our own pipelines and tankers to carry oil from well to refinery, or refined products to areas where they'll be used.



And if the fisherman then sells his product through a store of his own, he completes his integration. Standard does it, too, through Company-owned stations (about 1 in 7 stations where Chevron gasolines are sold). Integration helps us do better for you and the nation, and so for ourselves.

I'd Like to Know... Many people write to Standard asking pertinent questions about the Company. We answer all letters individually, but some points seem of general interest. We take this way of discussing them for every one. If you have a question, we urge you to write in care of: "I'd Like to Know," 225 Bush Street, San Francisco 20, California.

STANDARD OIL COMPANY OF CALIFORNIA

• plans ahead to serve you better

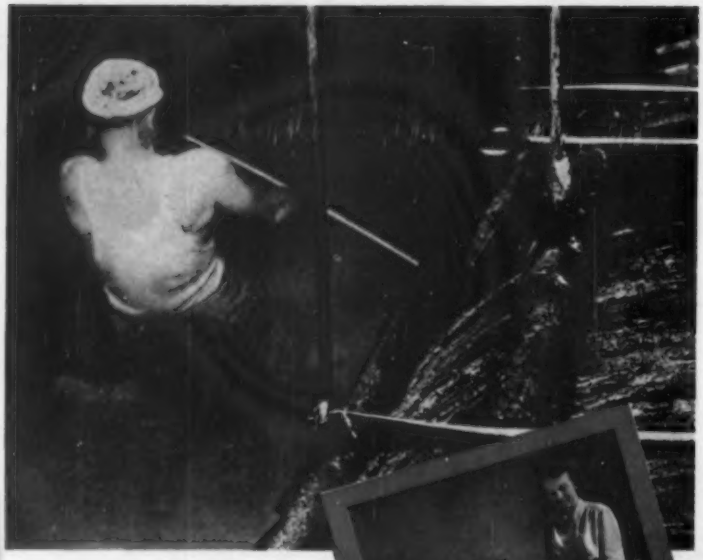
UNIFORMITY

Makes the Big Difference

in FILTER Fabrics

MT. VERNON EXTRA

Gives You Greater Fabric Uniformity



The greater uniformity of Mt. Vernon Extra means more efficient filtering — greater clarification of filtrates, more complete recovery of solids.

AT YOUR SERVICE

Mt. Vernon-Woodberry's staff of textile engineers is available on request to help you with your problems in development or application of industrial fabrics.

Mt. Vernon - Woodberry Mills

TURNER HALSEY COMPANY
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This Assembly is Ready to Go

Here's an assembly that's ready to go to work in a wide variety of high-temperature, high-pressure bolting applications. It consists of the Bethlehem Alloy Steel Continuous-Thread Stud, and two Bethlehem Quenched Nuts.

The Bethlehem Alloy Steel Continuous-Thread Stud is ideal for economical high-temperature, high-pressure bolting because it minimizes stress concentrations. There being no point of thread runout, stress concentrations can't concentrate at any one point, but instead are effectively distributed over its entire working length.

And the Bethlehem Quenched Nut, supplied with the Bethlehem Alloy Stud, has plenty of staying power because of its built-in strength. The quenched nut is unlike ordinary nuts because it is made by forging and extruding hot metal into a forming die, after which it is quenched and tempered. This procedure provides sufficient strength for the nut to break virtually any stud or bolt on which it may be used.

Bethlehem Alloy Continuous-Thread Studs and Quenched Nuts are made in a complete range of sizes. They form an effective, long-lasting combination for high-temperature bolting—one that's well worth looking into.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Bethlehem supplies every type of Fastener

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

RUGGED Simplicity

Correctly engineered mechanically and metallurgically, all body assemblies of R-S Valves equal or exceed A. S. A. standards in every detail. These valves are designed and constructed for rugged service and provided with such safety factors that they will exceed service expectations as well as reduce pumping and blower costs.

Consider also the few working parts, greater control rangeability, the self-cleaning feature and the fact that R-S Valves are readily adapted to automatic operation. Know the rugged simplicity of R-S Valves, and get the most from your valve investment.

District offices are listed in telephone directories as, "R-S Products Corp'n Valves".

R-S PRODUCTS CORPORATION
4600 Germantown Avenue, Philadelphia 44, Pa.
An S. Morgan Smith Company Subsidiary

R-S VALVES
Simplify the Control and Shut-off of Volume and Pressure from 2 to 2500 psig
Write for catalogs 17 and 18

No. 739-740—Sixty-inch, 50-pound Heavy Duty Valve with gear reduction drive and handwheel for handling water at 40 psig. Vertical valve stem enclosed in steel pipe support. Thrust bearing absorbs vertical load.

No. 730—R-S Heavy Duty Floor Stand for rugged service in connection with any standard R-S handwheel operated valve.

No. 767—A 3-Way Valve (Two 24-inch 125-pound Cast Iron Valves bolted to 125-pound American Standard Tee). Electric motor operated by cross linkage. Automatic declutching handwheel for emergency operation.

New look for old bearings

Santolube 394-C and Santolube 395-X are Monsanto's corrosion inhibitors and anti-oxidants which, added to suitable base stocks, produce motor oils that protect hard alloy bearings and keep them looking like new.

These additives improve lubricant stability and engine performance by minimizing lubricant oxidation, acid formation and sludge and varnish deposits, and by inhibiting bearing corrosion and lubricant thickening.

SANTOLUBE 394-C, with suitable base oils, may be used alone to compound premium-type lubricants, or it may be combined with detergent-dispersant additives, such as Santolubes 203-A, 303-A and 520, in proper oils, to get "Premium," "Medium Duty" and "Heavy Duty" lubricants.

SANTOLUBE 395-X was designed primarily for compounding "Premium" motor oils. It also may be used in combination with detergent-dispersant additives to make "Medium Duty" and "Heavy Duty" oils.

Both additives can be blended by using conventional equipment and methods. For further information, write MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1775-J South Second Street, St. Louis 4, Missouri.

SANTOLUBE 394-C
(Typical Inspection Values)

Specific Gravity at 60°/60° F.	1.02
Viscosity S.U.S. at 210° F.	90
S.U.S. at 100° F.	2850
Flash Point °F.	200
Color ASTM (diluted)	3
% Phosphorus	4.7
% Sulfur	13.0

SANTOLUBE 395-X
(Typical Inspection Values)

Specific Gravity at 60°/60° F.	1.01
Viscosity S.U.S. at 210° F.	85
S.U.S. at 100° F.	1675
Flash Point °F.	230
Color ASTM (diluted)	5
% Phosphorus	3.8
% Sulfur	10.7
% Barium	1.0

MONSANTO PETROLEUM ADDITIVES

Pour-point depressants
SANTOPOUR*
SANTOPOUR B

Motor-oil inhibitors
SANTOLUBE* 395-X, 394-C

Viscosity-index improver
SANTODEX*

Gear-lubricant additive to meet requirements of Federal specification VV-L-761
SANTOPOID* 5

Gear-lubricant additives to meet requirements of military specification MIL-L-2105
SANTOPOID 29, 32, 33

Motor-oil detergents
SANTOLUBE 203-A, 303-A, 520

Corrosion inhibitor for distillate fuels
SANTOLENE* C

Sludge inhibitor for domestic fuel oils
SANTOLENE E

Cutting-oil additive
SANTOLUBE 32

Inhibitor-detergent combinations for premium and heavy-duty service
SANTOLUBE 205, 206, 360, 374, 379, 388, 521, 522

URGENT—Please round up tank cars, carboys and returnable drums and send them back to your chemical supplier. Containers are extremely short.

*Reg. U. S. Pat. Off.

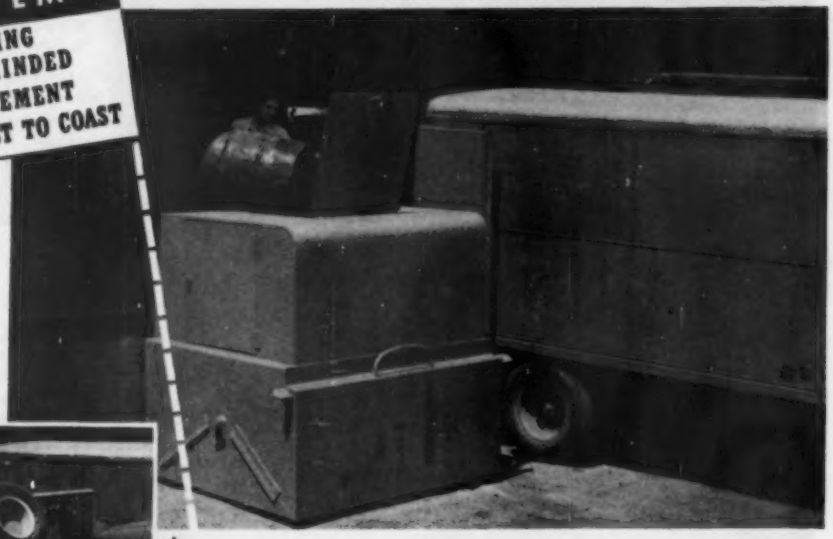
MONSANTO
CHEMICALS—PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND

DEMPSTER DUMPSTER SYSTEM

SERVING COST-MINDED MANAGEMENT FROM COAST TO COAST

. . . handling bulk materials of every description at phenomenal savings



Photos show a Universal Type Container being loaded, Dempster-Dumpster ready to pick it up and place it in carrying position, and container being emptied. Entire operation is handled hydraulically by means of controls at driver's seat.

DOW CHEMICALS INDISPENSABLE TO INDUSTRY AND AGRICULTURE

—recognized across the nation

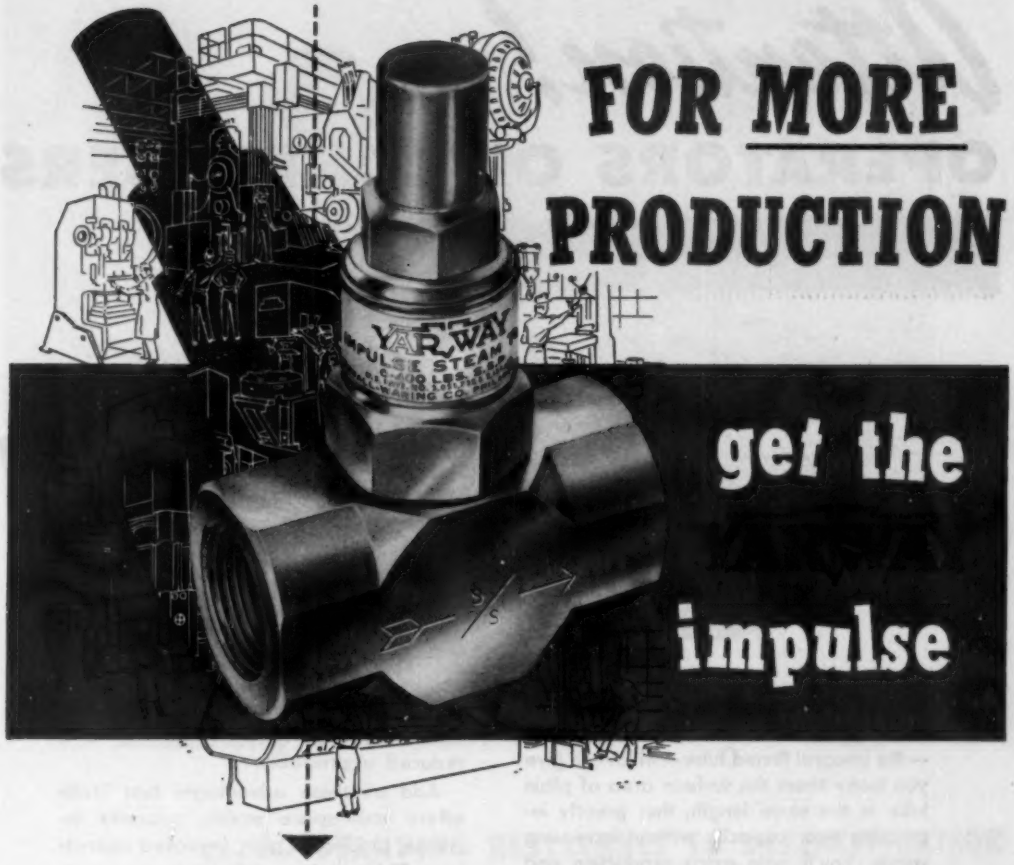
. . . The Dow Chemical Company, well known for sound management, uses the Dempster-Dumpster System

The Dow Chemical Company is among the hundreds of well managed manufacturers, both large and small, who use the Dempster-Dumpster System of bulk materials handling . . . the system recognized across the nation for its efficiency and ability to reduce costs.

Increasing man-hour efficiency is one of the important advantages of handling bulk materials with the Dempster-Dumpster System. One Dempster-Dumpster, with only one man, the driver, services any number of detachable Dempster-Dumpster Containers, which are spotted at convenient materials accumulation points inside and outside plants. In this system there are no loading crews to stand idle while truck makes haul, and no re-handling of materials. Dempster-Dumpster Containers are available in a wide variety of designs and sizes, up to 12 cu. yds., to suit the type of materials handled—be they bulky, light or heavy . . . solids, liquids or dust . . . trash or rubbish. The Dempster-Dumpster System also reduces investment in equipment and maintenance costs . . . improves "housekeeping" methods . . . reduces fire hazards . . . and provides an easier, quicker, safer and more efficient manner of handling materials. It will pay you to investigate the Dempster-Dumpster System of plant materials handling now! Manufactured exclusively by Dempster Brothers, Inc.

One Dempster-Dumpster Services All Containers. . . All Designs. . . All Sizes

DEMPSTER BROTHERS, 591 Dempster Bldg., Knoxville 17, Tennessee



FOR MORE PRODUCTION

get the impulse

Want more production from your steam-heated equipment? Yarway Impulse Steam Traps may be your answer! Here's why. Yarway Impulse Traps provide constant and complete condensate drainage, plus air and gas removal, plus velocity scrubbing of heat-retarding condensate from the heat transfer surfaces. In plant after plant, **equipment drained with Yarways gets hotter, sooner... and stays hot!**

FREE TRAP BOOK

It's full of valuable steam trap data. Write for your free copy of this new 24-page book today.

The exclusive Yarway "impulse" design has other advantages. For example—small size, one moving part, straight line piping, good for all pressures, low cost and low maintenance.

Nearly 750,000 Yarways have already been installed in thousands of plants in nearly every industry. Get Yarways from your nearby industrial distributor . . . 216 stock and sell Yarways.

YARWAY

the steam trap designed with more production in mind

YARNALL-WARING COMPANY ● 128 MERMAID AVENUE, PHILADELPHIA 18, PA.

Attention!

OPERATORS OF CONDENSERS

Instead of retubing with plain tube, install finned tube. We mean Wolverine Trufin* —the integral finned tube—which will give you many times the surface area of plain tube in the same length; thus greatly increasing your capacity without increasing space. You'll gain extra production and improve your efficiency. Vital considerations today.

Moreover, the surface area thus obtained through the use of Trufin affects further economies in producing most petroleum condensates.

Since the fins of Trufin are extruded from the outside wall of a plain tube—hence a part of the tube itself—this unique tube will withstand vibration and sudden temperature changes.

And quite important, too, is the fact that retubing and "shut down" time is reduced appreciably.

Add all these advantages that Trufin offers you—space saving, capacity increase, production gain, improved operating efficiency, lowered maintenance cost, less "shut down" time, and many more—you can recognize the wisdom of specifying Wolverine Trufin for your next retubing job.

Conserve metal, men, and machines.

WOLVERINE TUBE DIVISION, Calumet and Hecla Consolidated Copper Company, Incorporated, *Manufacturers of seamless, non-ferrous tubing,* 1431 Central Avenue, Detroit 9, Michigan.

*Reg. U.S. Pat. Off.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ont.

Wolverine Condenser Tubes stocked by Butler Industries, Inc., 355 South Fourth Street, Beaumont, Texas. Tel.: Beaumont 5-2351.

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
Sales Offices in Principal Cities

Export Department, 13 E. 40th St., New York 16, N. Y.

Why Phosphorized Admiralty Condenser Tubes?

...OUTSTANDING RESISTANCE TO DEZINCIFICATION

Adding as little as 0.02% phosphorus to Admiralty greatly increases its resistance to dezincification, without impairing its excellent chemical and physical properties.

In refinery applications, Scovill Phosphorized Admiralty Tubes have given maximum trouble-free life, proving to be relatively immune to dezincification and in addition, highly resistant to attack by sulfides and other active sulphur compounds encountered in this service.

In order to assure *uniform* chemical composition and *soundness*, Scovill produces its Phosphorized Admiralty tubes by the *continuous* billet-casting process which continuously maintains the optimum amount of phosphorus. The tubes are hot-extruded from the continuous-cast billets, then are cold-drawn, annealed, cleaned and finished to produce tubes of uniform temper, gauge, straightness, roundness, diameters, length and freedom from burrs.

A Condenser Tube Booklet is available to qualified users who request it on their business letterhead. Scovill Manufacturing Co., 14 Mill St., Waterbury 20, Conn.

Only Scovill Phosphorized Admiralty Has All These Advantages . . .

- Uniformity and soundness resulting from Scovill continuous-casting techniques
- Relative immunity to dezincification
- High resistance to sulfides and other active sulphur compounds
- Superior performance in fresh, salt, or brackish waters
- Satisfactory resistance to weak mineral acids and acid mine waters
- Good resistance to velocities under 7 fps.
- Excellent performance at relatively high operating temperatures

SCOVILL

A PRODUCT OF SCOVILL

SCOVILL CONDENSER TUBES

"You can't buy better brass"

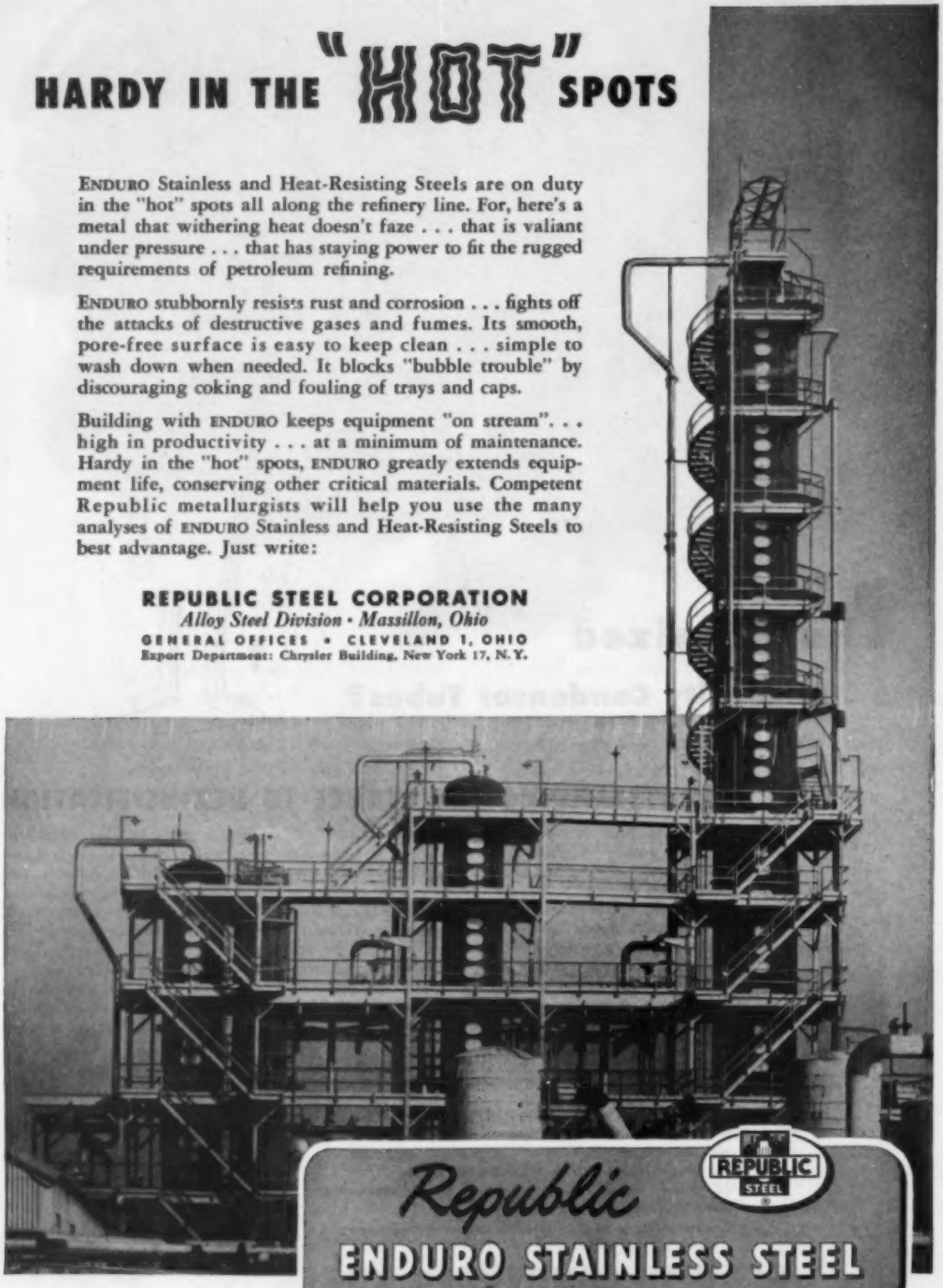
HARDY IN THE "HOT" SPOTS

ENDURO Stainless and Heat-Resisting Steels are on duty in the "hot" spots all along the refinery line. For, here's a metal that withering heat doesn't faze . . . that is valiant under pressure . . . that has staying power to fit the rugged requirements of petroleum refining.

ENDURO stubbornly resists rust and corrosion . . . fights off the attacks of destructive gases and fumes. Its smooth, pore-free surface is easy to keep clean . . . simple to wash down when needed. It blocks "bubble trouble" by discouraging coking and fouling of trays and caps.

Building with ENDURO keeps equipment "on stream". . . high in productivity . . . at a minimum of maintenance. Hardy in the "hot" spots, ENDURO greatly extends equipment life, conserving other critical materials. Competent Republic metallurgists will help you use the many analyses of ENDURO Stainless and Heat-Resisting Steels to best advantage. Just write:

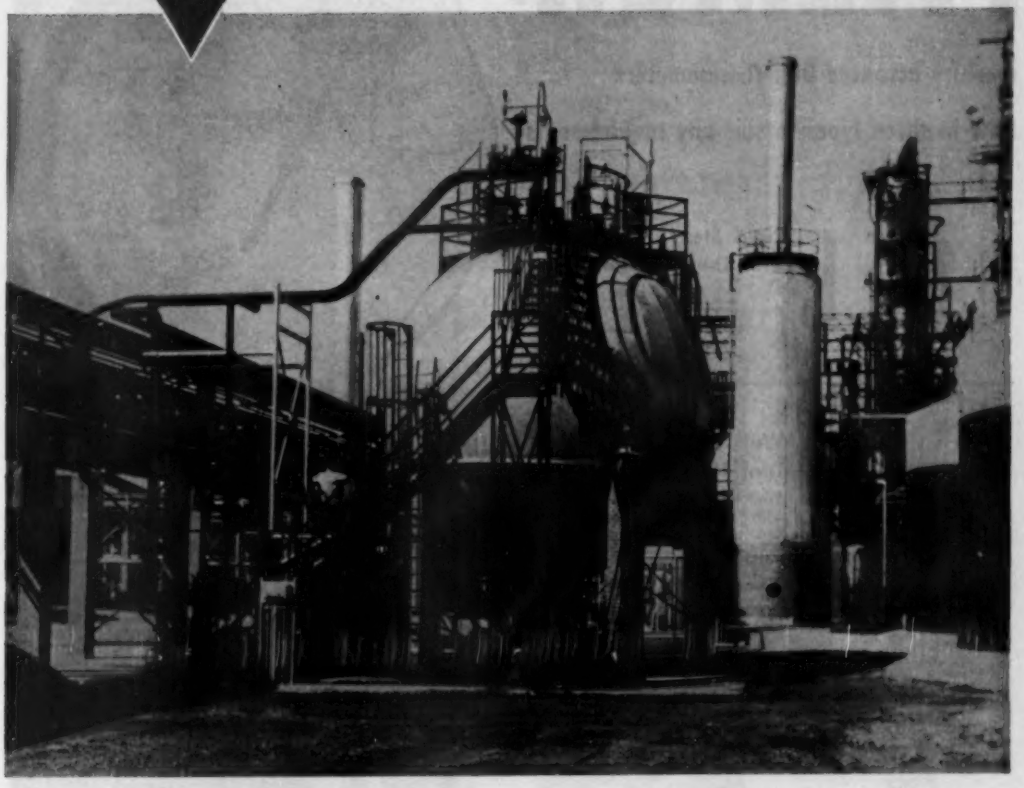
REPUBLIC STEEL CORPORATION
Alloy Steel Division · Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.



Republic
ENDURO STAINLESS STEEL

Other Republic Products include Upson Bolts, Studs, Nuts and Rivets—Pipe—Sheets—Plates—Electrunite Heat Exchanger Tubes

CONOCO *another leading refiner who desalts with PETRECO*



CONTINENTAL OIL COMPANY is now using Petreco Desalting in four different refineries—New Mexico, Oklahoma, Texas and Louisiana. Four successive installations by a refining organization with Conoco's established reputation is ample evidence that Petreco Desalting proved itself once for Conoco, and has continued to do so with each successive installation. If you want the best in salt removal performance, specify Petreco and be assured of

Minimum Residual Salts and Solids
Reduced Furnace Plugging
Maximum Exchanger Efficiency
Reduced Corrosion in Topping Section
Savings in Salvaged Waste Oil
Consistently Clear Water Bleed
Trouble-free Automatic Operation

PETRECO OFFERS COMPLETE DESALTING SERVICE AND FACILITIES

PETROLEUM RECTIFYING COMPANY
5121 So. Wayside Dr., Houston 3, Texas
1390 E. Burnett St., Long Beach, Calif.

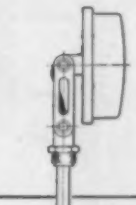
PETRECO
SPECIALIZED Electric PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PR 51-9

PALMER

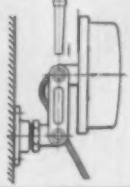
mercury actuated Dial Thermometers

now in three types to suit any requirements



1 Rigid Stem Dial Thermometer

Rigid stem tapered bulb, interchangeable with standard industrial thermometer separable socket.



2 Wall Mounted Dial Thermometer

Wall mounted dial thermometer with flexible connecting armor. Case adjustable to easy reading position.

3 Flush Mounted Dial Thermometer

Flush mounted style for panel mounting with flexible connecting armor.

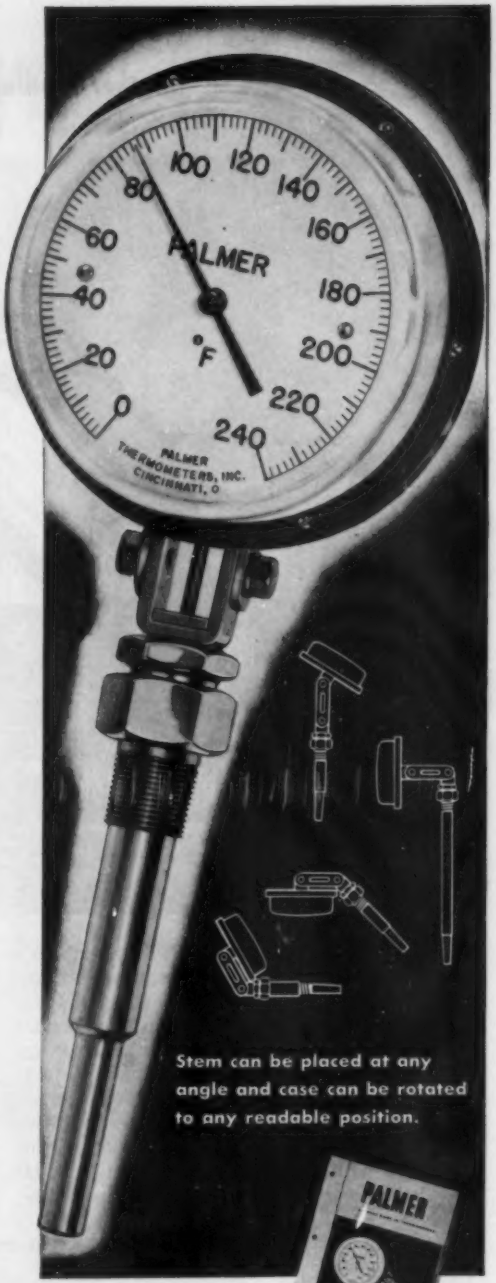
All three types have a full 4½" dial Face

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensation. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.



Stem can be placed at any angle and case can be rotated to any readable position.

SEND FOR THIS BULLETIN
For details on the New Palmer Dial Thermometer, please write for Palmer Bulletin 51-129.

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

2515 NORWOOD AVE., CINCINNATI 12, O.

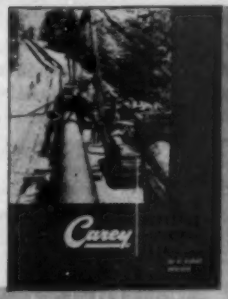
If YOUR JOB INVOLVES

- oil or gas pipelines
- processing operations
- refinery construction or maintenance...

You need this helpful literature!

Asbestos pipeline felt data book...

a discussion of protective coatings for pipelines by a competent corrosion engineer. Covers the fundamentals of low cost, dependable pipeline protection. Timely, informative, fully illustrated.

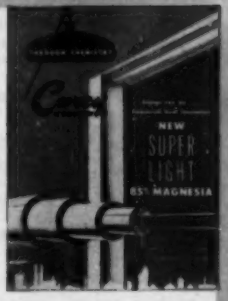


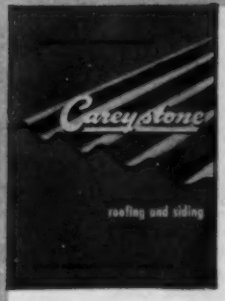
Carey MW-50 data book...

describes the most modern method for insulating all types of heated equipment having temperature ranges up to 1600°F., and gives details for applying insulation on irregular or hard-to-reach surfaces.

Super-Light 85% magnesia data book...

description, specifications and recommended uses for a new, improved insulation in precision-sized monolithic blocks, molded pipe coverings and cements.





Careystone corrugated asbestos-cement roofing and siding data book...

technical data, application details and specifications covering the economical use of Careystone asbestos-cement for all types of buildings.

Get the Carey Data Books you need absolutely free. Ask your Carey Industrial Sales Engineer, or just fill in coupon and mail today. No obligation!

Carey ASPHALT ASBESTOS MAGNESIA PRODUCTS

THE PHILIP CAREY MFG. CO., LOCKLAND, CINCINNATI 15, OHIO
IN CANADA: THE PHILIP CAREY CO., LTD. 277 DUKE ST. MONTREAL 3, P.Q.

The Philip Carey Mfg. Co.
Lockland, Cincinnati 15, Ohio
Department PR-9

Gentlemen: Please send me without charge the Carey Data Books on ☐ PipelineFelt ☐ Super-Light 85% Magnesia Insulation ☐ MW-50 Cement ☐ Careystone Asbestos-Cement Roofing and Siding. Place check mark in box before Data Books wanted.)

Name _____

Company _____

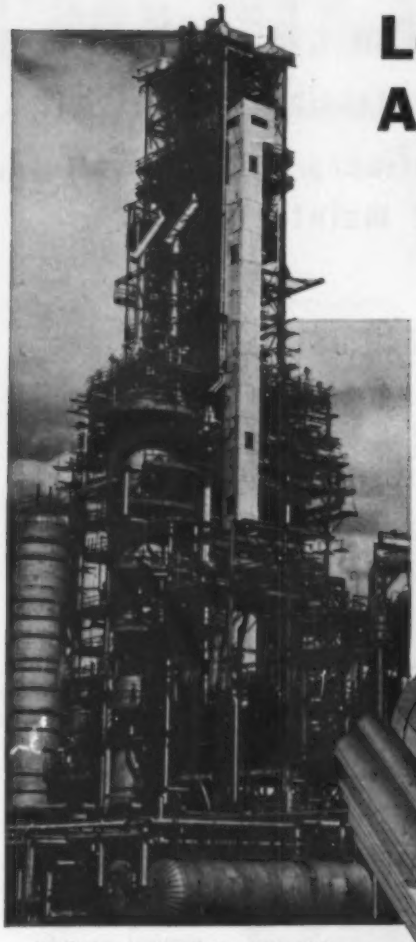
Address _____

Position _____

City _____ Zone _____ State _____

Another Example of the Trend...

Leading Refiners Are Switching to KAYLO HEAT INSULATION



Never before has there been an insulating material with the combination of important advantages provided by Kaylo Heat Insulation. More and more it is becoming recognized throughout industry as the first major advancement in the high-temperature field.

Kaylo Heat Insulation is a calcium silicate (not glass), an inorganic material with remarkable stability. Its high effective temperature limit—1200°F.—eliminates the need for combination covering in nearly all operating conditions.

Kaylo Heat Insulation is insoluble in water and incombustible. Its light weight and high strength make it easy to handle and apply.

KAYLO PIPE INSULATION is made to Simplified Dimensional Standards of thicknesses and diameters. Coverings are sectional for tube and pipe sizes ¼" to 12"; tri-segmental up to 23"; quad-segmental up to 41"; K-segmental (18" wide segments) up to 72" in diameter.

KAYLO HEAT INSULATING BLOCK is made in all standard sizes and thicknesses from 1" to 6" for flat surfaces and for vessels larger than 60' in diameter; curved block 18" wide for smaller vessels.

The first major installation of Houdriflow "cat" crackers — a 308-ft. quadruple-reactor catalytic cracking unit — Sun Oil Company's Plant 5 at Toledo, Ohio. The entire catalyst system is insulated with Kaylo Heat Insulation.

SEE OUR CATALOG IN THE REFINERY CATALOG

For complete details on Kaylo Heat Insulation, write Dept. N-169, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

KAYLO® ... *first in calcium silicate*

...*pioneered by* OWENS ILLINOIS Glass Company

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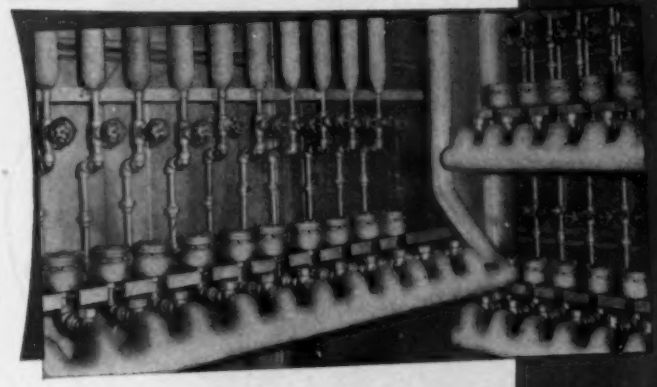
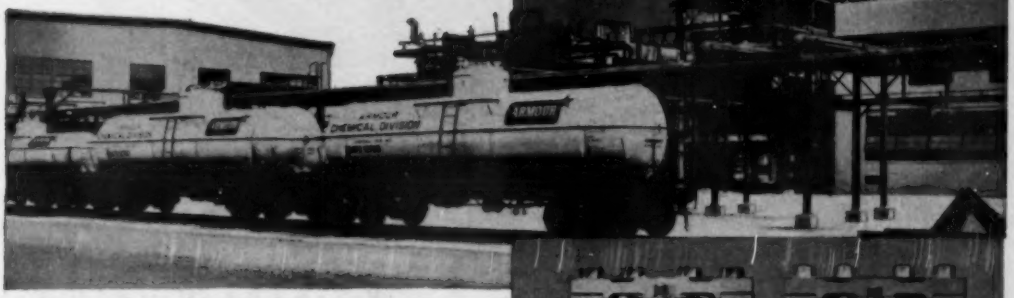
NICHOLSON TRAPS SELECTED

for Armour Chemical Plant

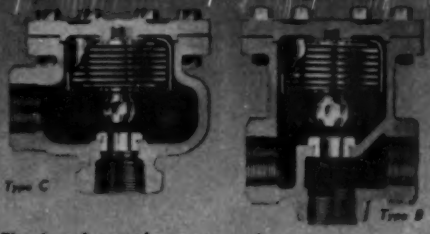




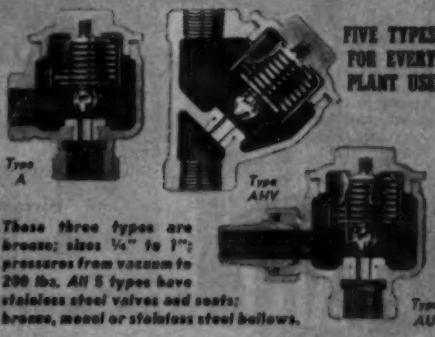
Above, new McCook, Ill., plant of Armour and Company's Chemical Division. Nicholson steam traps were specified throughout. Left above, a battery shown on tracer lines warming fatty acids.

Many chemicals are made available in commercial quantities for the first time by this new Armour Chemical Division plant. With demands for process steam alone as high as 80,000 pounds per hour, the entire plant is equipped with Nicholson steam traps, both grounds and buildings.

Features of Nicholson thermostatic steam traps: 2 to 6 times average drainage capacity; shorten heat-up time. Operate at lower temperature differential; fast action keeps equipment full of live steam. Maximum air-venting capacity. Freeze-proof. Types for every process, power, heat application.



The two types above are cast iron; sizes ½" to 2"; pressures from vacuum to 225 lbs. Type C also in cast steel for pressures to 300 lbs.



These three types are bronze; sizes ¼" to 1"; pressures from vacuum to 200 lbs. All 5 types have stainless steel valves and seats; bronze, monel or stainless steel bellows.

Send for NICHOLSON TRAP CATALOG 751

Catalog 751 contains capacity tables, installation diagrams, and data, charts and formulas for determining the proper size trap.

W. H. NICHOLSON & CO.

207 OREGON ST., WILKES-BARRE, PA.

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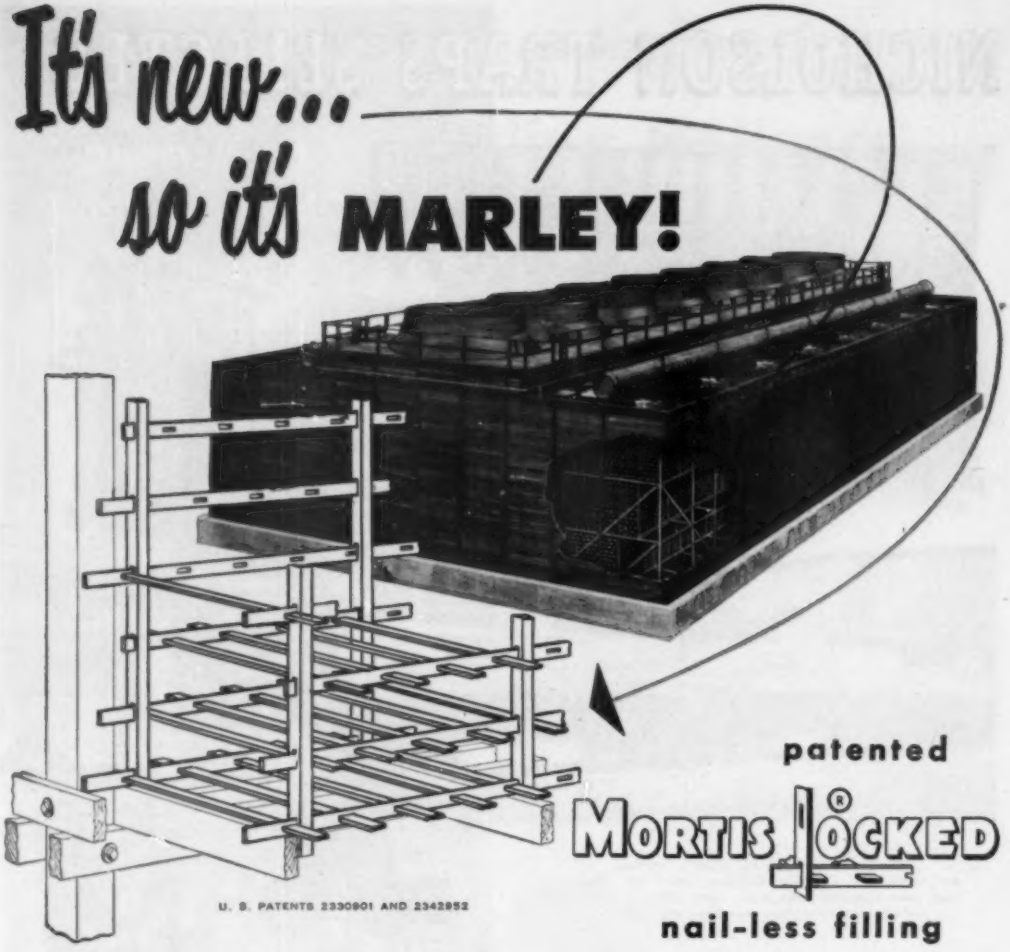
It's new... so it's MARLEY!



U. S. PATENTS 2330901 AND 2342852

patented

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. . . THE COOLING TOWER FILLING THAT BREATHES

. . . has long been an important factor in making Marley Double-Flow the world's leading water cooling tower. Now it's redesigned for even greater ruggedness, more long-lasting stability.

And it retains its ability to expand and contract with every variation of temperature and moisture.

Design simplicity is the keynote of MortisLocked filling . . . no nails, bolts or spacer blocks are needed. There are no parts to rust, corrode or fall out. Bulletin ML-51 graphically portrays MortisLocked superiority . . . write for it now.

Producers of
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The Marley Company, Inc.

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Don't let corrosive media *eat away your profits!*

We know that to have production in the Chemicals or Process Industries you must have corrosive media. We also know that "down time" caused by corroded valves slows up production and therefore "eats away" your profits.

But why worry? Powell makes valves of the *right* materials to resist the action of every known form of corrosive media encountered in these industries.

Gate, Check, Globe and Y Valves, in Bronze, Iron, Steel and Corrosion-Resisting Metals and Alloys

★ *Quality fine throughout "The Line"* ★

Fig. 2453-G. Large 150-pound O. S. & Y. Gate Valve. All the dimensions conform to the latest standards. Can be furnished in: Stainless Steels, Hastelloy Alloys, Monel Metal, Herculoy, Everdur, Inconel, Nickel, and other metals and alloys.

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AUTOMATIC CONTROL EQUIPMENT

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maximum work-
0 PSI and tempera-
0°F. to 1200°F.
ge from ½" thru 12" (C_V: 0.001
440) will accurately control extremes
in flow, temperature and pressure on air, water, steam, oil or gas service.

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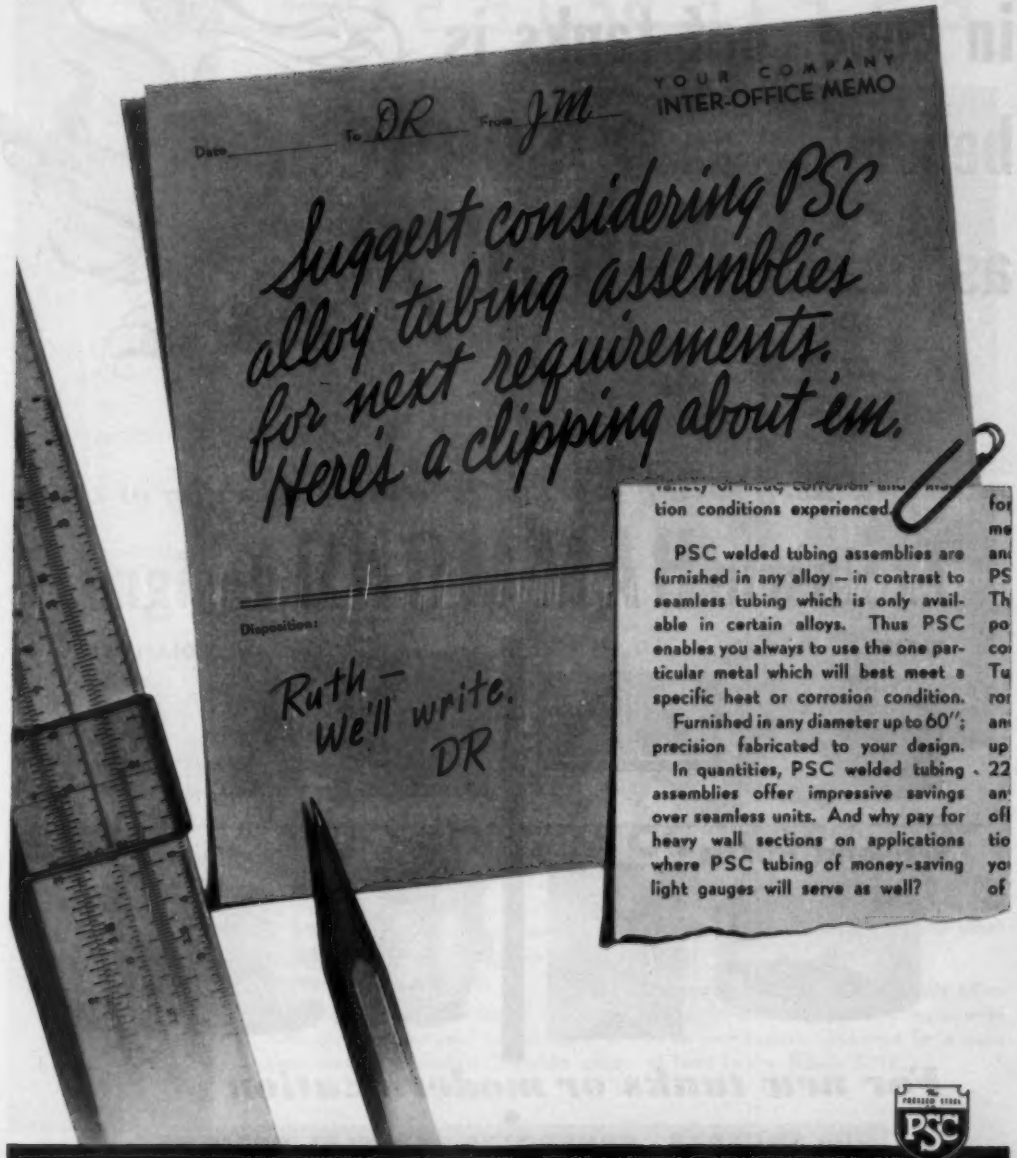
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To DR
From JM
YOUR COMPANY
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Suggest considering PSC alloy tubing assemblies for next requirements. Here's a clipping about 'em.
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PSC welded tubing assemblies are furnished in any alloy — in contrast to seamless tubing which is only available in certain alloys. Thus PSC enables you always to use the one particular metal which will best meet a specific heat or corrosion condition.
Furnished in any diameter up to 60"; precision fabricated to your design.
In quantities, PSC welded tubing assemblies offer impressive savings over seamless units. And why pay for heavy wall sections on applications where PSC tubing of money-saving light gauges will serve as well?

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Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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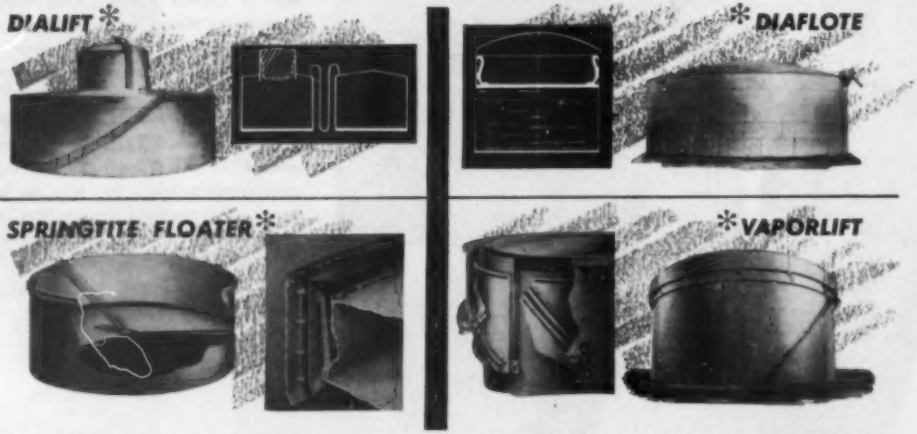
Storing volatile products in cone roof tanks is becoming as obsolete as the dodo bird!

● *DODO, a large bird formerly inhabiting the Island of Mauritius, but now extinct . . . the Dutch called them Walgoogels, i.e., nauseous birds, because no cooking made them palatable. Man and the hogs and other animals he imported effected its extermination.—Britannica*

modern money saving storage is available in any of these

exclusive HAMMOND designs



For new tanks or modernization of old

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also SPHERES · SPHEROIDS · SPECIAL DESIGNS

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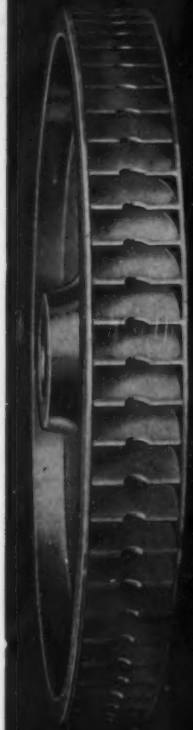
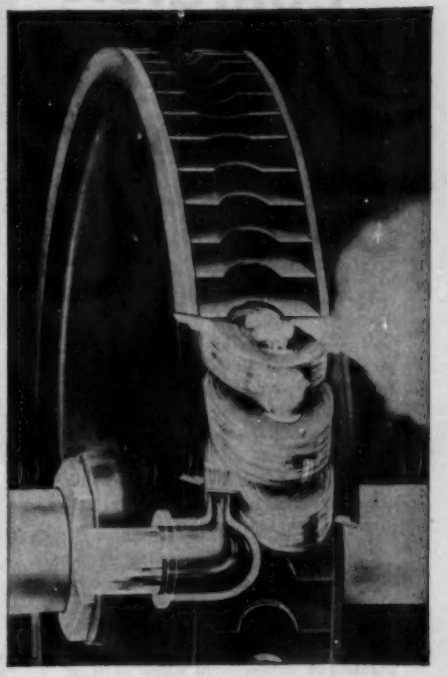
TERRY





Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

NO PARTS TO LOOSEN OR WORK OUT

The rotor of the Terry Wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the solid curved backs of these buckets or pockets. Therefore close clearance is unnecessary and wear on the blades forming the pockets is of little consequence, as it does not materially affect horsepower or efficiency.

For detailed information about this effective construction and its advantages, write us on your business letterhead for a copy of Terry Turbine Bulletin S-116.

T-1172

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

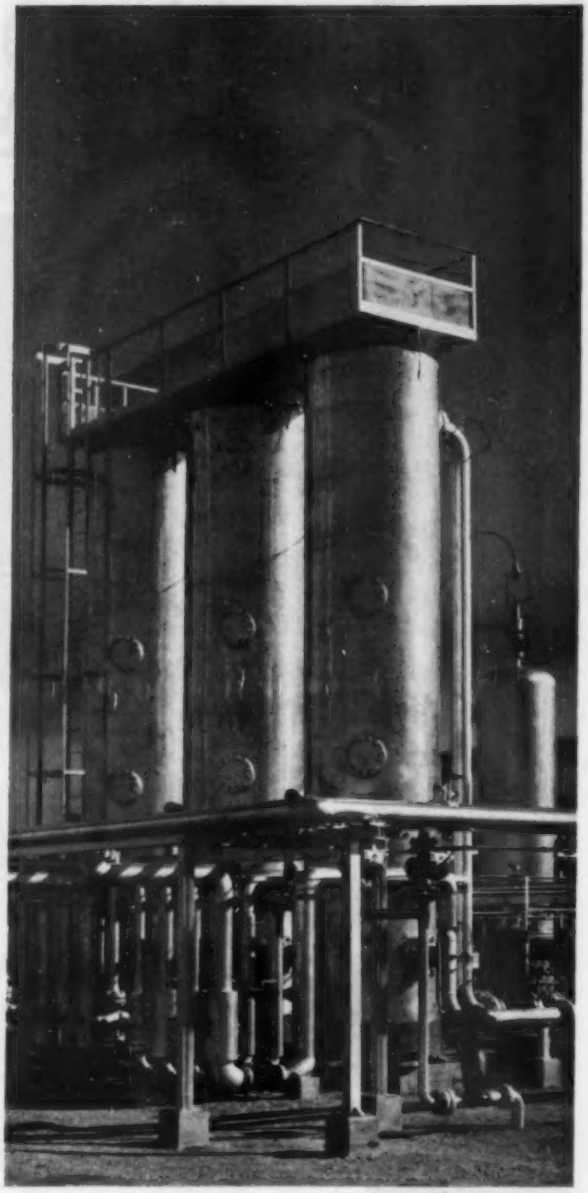
HORTON Dehydrators

. . . SERVE EFFICIENTLY AT NEW NATURAL GASOLINE PLANT

The three Horton dehydrators shown at the right, are now in operation at the Gulf Oil Corporation's new gasoline plant at Eunice, New Mexico. They are an integral part of the equipment that daily produces up to 1200 barrels of 20-lb. Reid vapor pressure natural gasoline, 750 barrels of butane, and 1600 barrels of propane for blending, chemical processing, industrial heating, and direct commercial uses.

These Horton steel structures and others such as catalyst storage bins, fractionating towers, and extractor towers, are daily playing an important part in the operation of many natural gasoline plants and refineries in many parts of the world. Their careful design, fabrication, and erection not only meets engineering and mechanical specifications—but also assures longer, more profitable service.

Let us furnish you with quotations on steel plate work or Horton vapor-saving storage units without obligation to you.



Three 54-in. by 24 ft. dehydrators built for Gulf Oil Corporation at Eunice, New Mexico.

CHICAGO BRIDGE & IRON COMPANY

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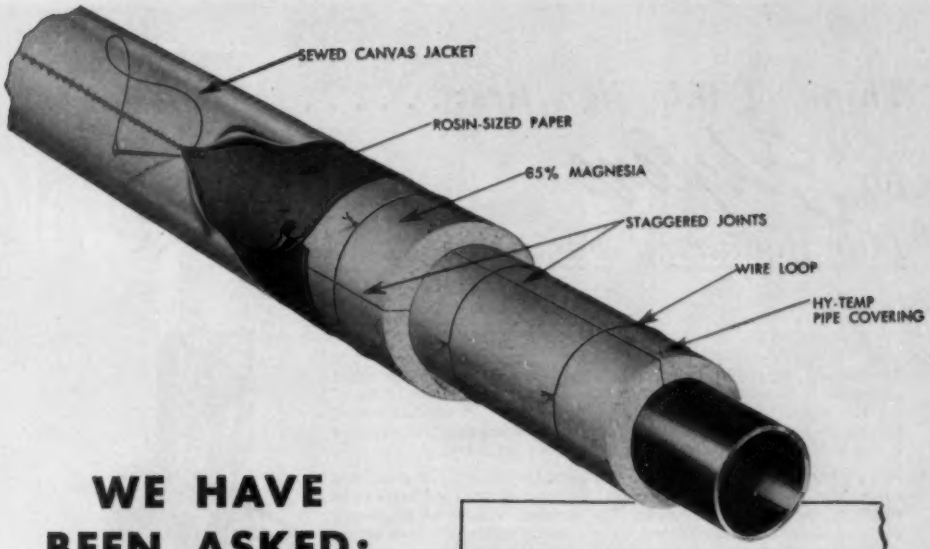

WE HAVE BEEN ASKED:

"What insulation do you recommend for a superheated steam line which operates at 1000° F.?"

"We are installing a 5" superheated steam line and plan to finish it with sewed canvas and paint to match existing lines," writes a power engineer. "What insulation do you recommend on a line like this?"

An efficient method of insulating this line would be a combination of Hy-Temp and 85% Magnesia Covering, each layer being 2" thick. Both layers of insulation should be applied with horizontal and vertical joints staggered so that there are no through joints where heat might escape. On high-temperature lines, this is important as it eliminates the possibility of heat's leaking through and burning the finish. Staggered joint construction also does away with the danger of fire in places where solvent fumes or other hazards are encountered.

With this construction, the layer of Hy-Temp Covering is applied first. This reduces the temperature at its outer surface to 600° F., the top temperature limit of the 85% Magnesia that is then applied to reduce heat loss further.

On many heat insulation jobs, there are places where proper application of materials can prevent burning of the finish, eliminate a fire hazard, or solve any one of dozens of other problems. Armstrong engineers can recognize those places before the insulation is applied and make the recommendations that will stop trouble before it occurs. The complete contracting service Armstrong offers also brings you top-quality materials and skilled workmen to apply them. The next time you have any insulation work to be done, it will pay you to get in touch with this reliable contractor.

SEND US YOUR QUESTIONS: If you have any questions on the use or application of either high- or low-temperature insulation, please do not hesitate to write us. We'll do our best to give you a practical answer. Just address a letter or post card to Armstrong Cork Company, 7509 Maple Avenue, Lancaster, Pennsylvania.

ARMSTRONG'S INDUSTRIAL INSULATIONS

MATERIALS - INSTALLATION

FOR ALL TEMPERATURES FROM [illegible] BELOW ZERO TO [illegible]° F.

Think of this sign first . . . . . .

for **Ethylene**

Manufacturing Facilities

The Lummus reputation for keeping its sights leveled at highly practical objectives is of particular value in the designing and constructing of ethylene manufacturing facilities. The very stature of ethylene—most important of hydrocarbon raw materials for petroleum chemical synthesis—should make such a point of view attractive to industry.

First, Lummus places emphasis on processing for higher yields and lower costs. Detailed processing and engineering studies dictate the scheme to be employed for specific operations. The company's fund of knowledge covering all commercially-applied techniques for making ethylene carries on from there. Lummus' pilot plant and development work have produced important tools to achieve maximum performance and flexibility. Special Lummus cracking heaters meet specific requirements for converting ethane, propane, or mixtures of both to an ethylene-rich effluent.

Second, Lummus places emphasis on the design of ethylene units for lower initial outlay, thus increasing the refiner's profit margin and diversity of income. This is extended to include recognition of metals-availability in the period ahead, as well as planning for rock-bottom maintenance and upkeep costs.

Third, Lummus recognizes the special responsibility of handling confidential information in accordance with the best interests and desires of the customer.

We invite you to think of Lummus first in *your* plans for petroleum chemical expansion.

THE LUMMUS COMPANY

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"DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

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New Convenience for the Southwest Area

You are cordially invited to visit our new plant and showroom at 1300 Industrial Boulevard, Dallas. Designed to specialize in the production of Orifice Meters and related equipment, it speeds deliveries and makes possible a personalized, sales-engineering service including consultations on instrument problems. The new showrooms afford complete facilities for conducting Instrument Schools for engineers and maintenance men. The complete line of American Meter Company products will also be on permanent display.

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INCORPORATED (ESTABLISHED 1836)

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Performance is the answer!

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(Horizontal and Vertical)

STEAM GENERATORS

JACKET WATER COOLERS

With the installation of EFCO heat transfer units in your plant, you will be sure of getting *guaranteed performance* with the extra advantages of low maintenance cost, high operating efficiency, long life and freedom from leaks.

Talk over your heat transfer problems with an EFCO engineer. He will tell you about EFCO installations that have successfully solved problems similar to yours and explain how EFCO equipment will give you the performance you want.

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EFCO HEAT TRANSFER EQUIPMENT

4,372 years of antiknock experience

This photograph will give you some idea of the experience that Ethyl brings to bear on oil-industry problems.

Assembled on the lawn in front of the Ethyl Research Laboratories in Detroit are some of our 432 full-time specialists in antiknocks, fuels, lubricants and engines. These researchers have an average of 18 years' experience in their varied fields, including an average of 10 years with Ethyl. The experience of this team, with Ethyl, adds up to a total of 4,372 years.

Like the faculty of a great university, a team of this caliber can be created only over a long period of time. While it is possible to hire individuals, the careful

(Continued on next page)

4,372 years of antiknock experience

(*Continued from preceding page*)

balancing and dovetailing of individual capabilities into an effective working group requires years. From such seasoning and experience have come the understanding of refiners' problems and the cooperation in their solution which have typified the work of the Ethyl team.

Ethyl started to build its fuels and engine research team in 1923. Originally it was housed in a converted garage. Today it works in extensive laboratories at Detroit, San Bernardino and Baton Rouge, where it is equipped with the most complete and best of research facilities. But its guiding principles remain the same—"Do anything and everything that will assist refiners to get the maximum benefit from every drop of 'Ethyl' antiknock fluid."

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NEW YORK 17, N. Y.

Experience *

is the most important ingredient in "Ethyl" antiknock compound

* RESEARCH

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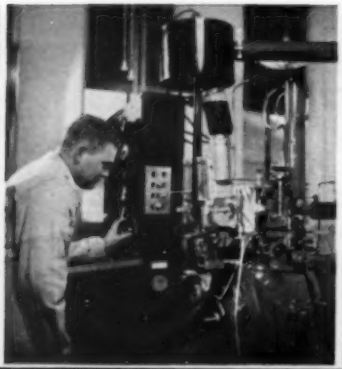
* GASOLINE TESTING



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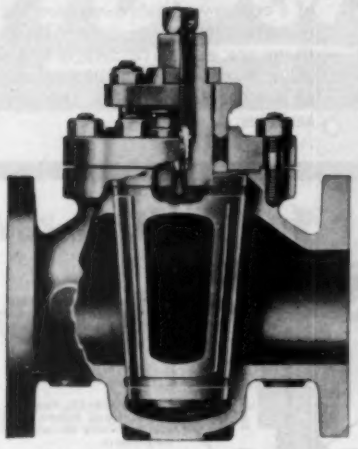
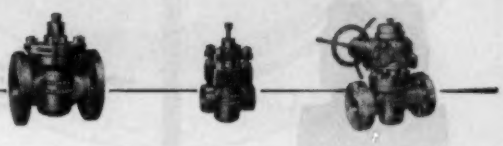
for TOUGH *assignments*

where tight shut-off...
and easy operation
are "MUSTS"





Walworth Lubricated Plug Valves Offer These Advantages

- Complete surrounding of ports with resistant lubricant affords positive seal against leakage.
- Lubricant grooving system assures ease of operation — tight shut-off — greater protection against corrosion.
- Body and plug fully protected by lubricant from attack by line fluids.
- Quarter turn opens or closes valve.
- Made in a complete range of sizes ½" to 26" and for pressures from 175 to 5,000 psi., and for vacuum requirements.

For handling petroleum products, natural or manufactured gas, acids, alkalies, solvents, slimes, slurries . . . in fact for almost any hard-to-handle liquids—there's a Walworth Lubricated Plug Valve designed for the job.

Easy to operate, tight sealing, resistant to wear and corrosion, Walworth Lubricated Plug Valves assure long years of dependable service at low operating cost.

Walworth Lubricated Plug Valves are available in sizes ½" to 26" for pressures from 175 to 5,000 psi., and for vacuum requirements. For full details—prices, sizes, dimensions, and other pertinent data, see your Walworth distributor or write to:

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NEW GENERAL PURPOSE

800# Hancock Gate

STEEL WELDVALVES

These new 800# Hancock General Purpose Steel Gate Weldvalves are the product of nearly three-quarters of a century of valve engineering and manufacturing experience. Built into them are exclusive design and operating features that assure extra years of top performance in the severest services.

800# HANCOCK STEEL GATE WELDVALVES

Bolted Bonnet Design

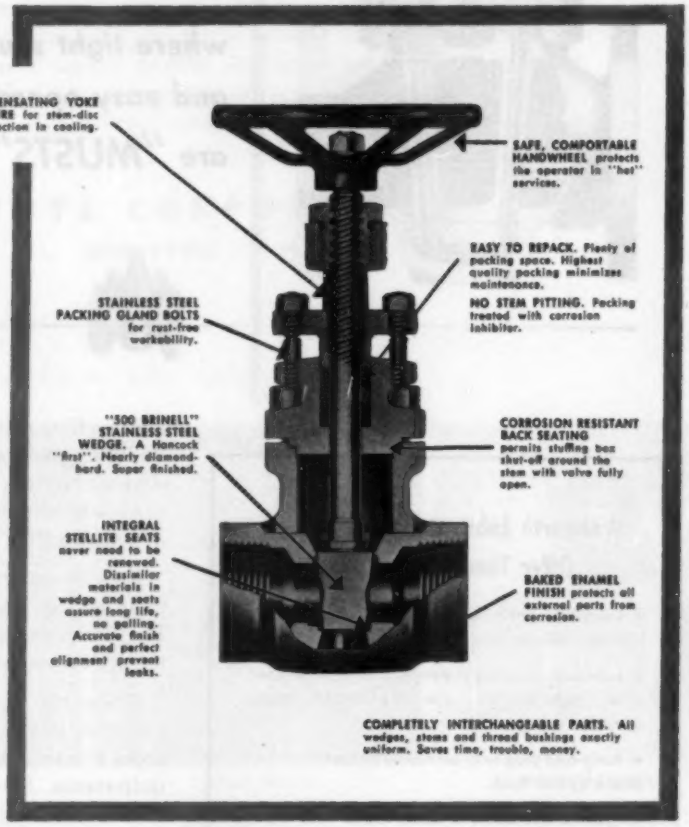
Sizes: 1¼" thru 2"

Screwed Ends . . . Socket Weld Ends . . . Flanged Ends

For *All* Pressures Up to 800 P.S.I. at 750° F.

O.W.G. 2000# 100° F.

General Purpose Hancock Steel Gate Weldvalves cost no more than ordinary valves — despite their recognized trouble-free dependability and long-life economy. Your nearby Hancock Valve Distrjbutor has the facilities and the stocks to give you fast, efficient service. Get the best for your money. Phone him.


COMPENSATING YOKE STRUCTURE for stem-disc contraction in cooling.
SAFE, COMFORTABLE HANDWHEEL protects the operator in "hot" services.
EASY TO REPACK. Plenty of packing space. Highest quality packing minimizes maintenance.
NO STEM PITTING. Packing treated with corrosion inhibitor.
STAINLESS STEEL PACKING GLAND BOLTS for rust-free workability.
"500 BRINELL" STAINLESS STEEL WEDGE. A Hancock "first". Heavily diamond-hard. Super finished.
CORROSION RESISTANT BACK SEATING permits stuffing box shut-off around the stem with valve fully open.
INTEGRAL STELLITE SEATS never need to be renewed. Dissimilar materials in wedge and seats assure long life, no galling. Accurate finish and perfect alignment prevent leaks.
BAKED ENAMEL FINISH protects all external parts from corrosion.
COMPLETELY INTERCHANGEABLE PARTS. All wedges, stems and thread bushings exactly uniform. Saves time, trouble, money.

When Hancocks go in, valve costs go down

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A product of **MANNING, MAXWELL & MOORE, INC.** WATERTOWN 72, MASSACHUSETTS

MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' ELECTRICAL AND INDUSTRIAL INSTRUMENTS. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

Probolog

gives accurate picture of heat exchanger tube condition . . .

Without removing tubes!

TODAY'S NEEDS place a high value on reliable tools and methods of failure-prevention. The Shell-developed Probolog is an outstanding example of such a tool.

Probolog, with speed and precision, gives you a *permanent record* of the condition of individual tubes in heat exchangers and other tube-nest equipment. This record instantly spots worn, eroded, or pitted sections of a tube.

Probolog is a one-man unit . . . simple, fast and dependable in its "judgment." It has an established record for unfailing accuracy, and for reducing maintenance costs in the inspection of non-magnetic tubular equipment.

Additional information on the Probolog will be sent upon receipt of your letterhead request.

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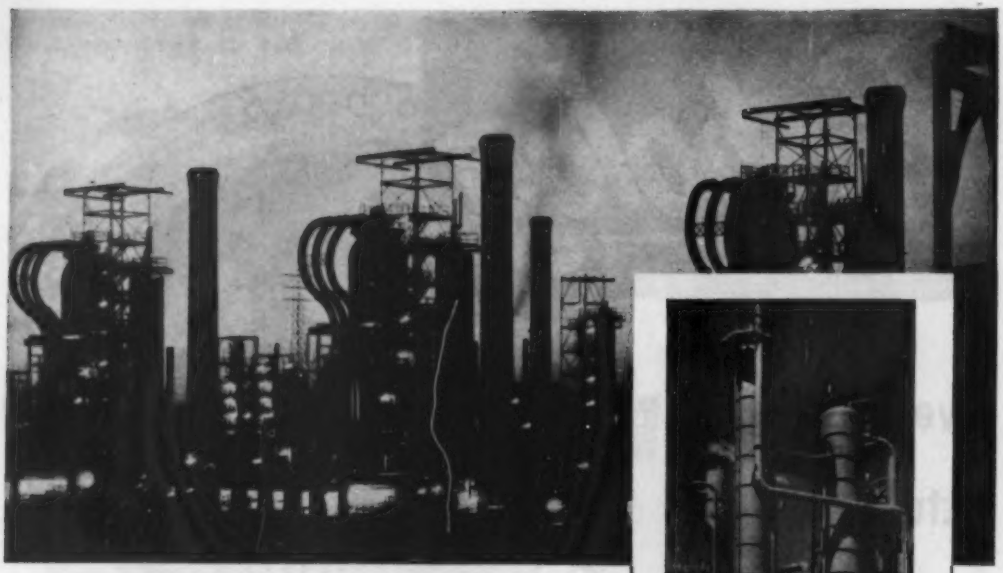
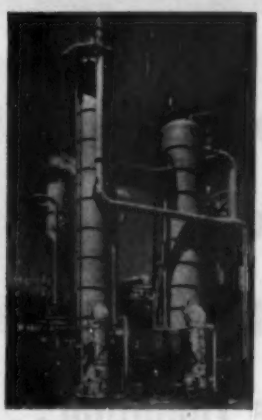




Fabricated by an equipment builder using the Lukenomics principle.

Equipment Report

...from a Petrochemical Operation

Temperamental efficiency giving your output plans an argument?

Mere replacement may not be the best solution. Perhaps you can do better. Consider, for example, design and fabrication know-how behind this clad steel distillation tower.

This is the responsible approach . . . the approach of a progressive equipment builder. The resourcefulness of such specialists is *your* best assurance of peak efficiency, economically achieved.

And builders like this apply Lukenomics, combining their own know-how with that of designer and engineer, as well as with our own knowledge of materials, their production and use.

Let us put you in touch with such resourceful builders. Write *today*, stating your problem. Manager, Marketing Service, Lukens Steel Company, 404 Lukens Building, Coatesville, Pennsylvania.

Promote steel production generally—speed sale of your scrap.

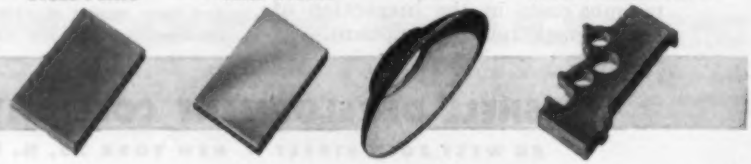
Here is a case where Lukenomics teamwork resulted in maximum productivity, economically achieved. Synthetic glycerine was to be purified by distillation in a column under high vacuum. The manufacturer supplied the *builder* with temperature, pressure and other process requirements. The column was then designed and fabricated to the specific needs. For assurance of high purity, at a sharp saving in equipment cost, Lukens Nickel-Clad Steel was used. Since completion, this tower has featured steady high output with rigid limits on maintenance and costs. And use of clad steel in this instance not only minimized initial cost, but saved important amounts of a scarce metal. *This is Lukenomics at work.*

LUKENS

LUKENS STEEL COMPANY

OVER 140 YEARS' EXPERIENCE AS THE WORLD'S LEADING PRODUCER OF SPECIALTY STEEL PRODUCTS

STEEL PLATE | CLAD STEELS | HEADS | STEEL PLATE SHAPES



There's a PETRO-CHEM ISO-FLOW *furnace* .....

for every fluid heating service, capacity or duty, irrespective of temperature pressure range.

for REFINERIES

crude distillation, vacuum distillation, thermal cracking, catalytic cracking, thermal reforming, catalytic desulphurization, catalytic reforming, solvent refining, isomerization

for RECYCLING PLANTS

catalysis heaters with catalyst in tubes, steam superheating to 1500°F, gas cracking, reactant distillation, direct fired reboiling

for CHEMICAL PLANTS

rich oil distillation, secondary fractionation, depropanizing, debutinizing, reboiling heat medium

for GAS PLANTS

at individual leases and for main line dehydration for catalyst regeneration—up to 500,000,000 cubic feet per day, unlimited pressure

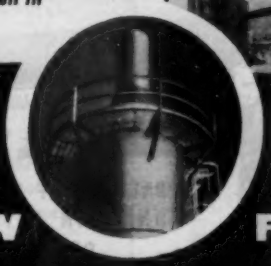
for PIPELINES

gas dehydration, gas and air superheating for turbine drives, reduction of viscosity of oil in long transmission lines

for ASPHALT PLANTS

including tank heating, loading heaters, manufacture of linoleum, roofing and tile—circulating heaters for saturates

Throughout the world, in the petroleum, chemical and allied industries, there are more than 800 Petro-Chem Iso-Flow Furnaces performing to the complete satisfaction of their operators and generally well in excess of their rated capacities.



PETRO-CHEM

ISO-FLOW FURNACES

UNLIMITED IN SIZE . . CAPACITY . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC., 120 EAST 41ST STREET, NEW YORK 17, N.Y.

REPRESENTATIVES

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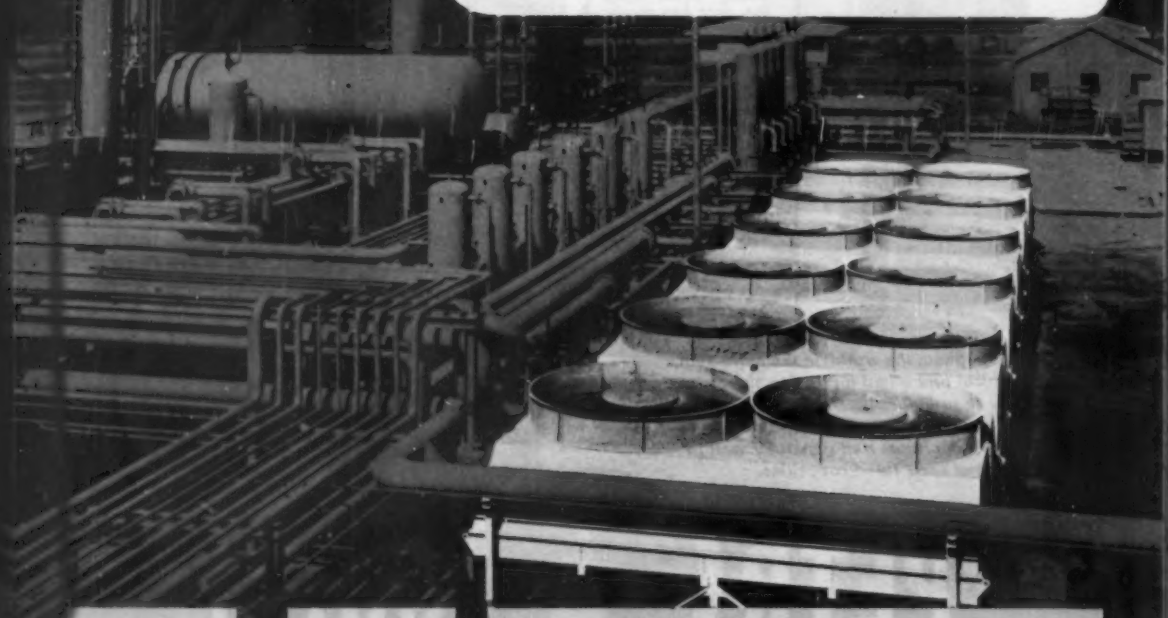
HUDSON AIR-COOLED UNITS

Hudson Air-Cooled Units are now transferring more than 500,000,000 BTU per hour of process heat from STEAM, GAS, JACKET WATER, HOT OIL and HYDROCARBON VAPORS directly to the air, obviating the use of water as an intermediate transfer medium.

Gears, drive shafts, fans, finned tube surfaces and structural steel supporting framework which make up the Hudson Air-Cooled Units are selected and designed for long life in continuous outdoor service. Drivers may be electric motors, steam turbines, gas engines, or hydraulic motors.

Hudson Air-Cooled Units are manufactured and assembled in the recently completed Hudson plant at Houston. This practice minimizes field assembly costs. The Hudson organization welcomes the opportunity of studying your over-all heat dissipation problem. Such studies will enable you to make the most advantageous selections of cooling equipment for your particular problem, whether it be cooling towers with water-cooled units, or air-cooled units, or combinations of the two.



HUDSON
ENGINEERING CORPORATION
FAIRVIEW STATION HOUSTON, TEXAS

BATTERY OF TWELVE HUDSON AIR-COOLED UNITS IN A TEXAS PROCESSING PLANT.
COOLING—HOT OIL AND GAS
CONDENSING—STEAM AND HYDROCARBON VAPORS

No matter where you sit

—Here...

or Here...

...you'll find it pays to make full use of

NATIONAL *service on* **LEAD EQUIPMENT**

Whether you're in planning or production ... take advantage of NATIONAL service whenever you need lead equipment for handling corrosive chemicals.

That means lead equipment in any form. Sheet or valves. Simple lead coils or custom-made processing vessels. Complicated acid-recovery equipment or a short run of pipe.

Take lead pipe as one example. If you want help in choosing or using lead pipe, call on NATIONAL. You'll get the benefit of our many years' experience in helping others select the correct piping for handling corrosive liquids.

NATIONAL supplies lead pipe and fittings in all types, sizes and weights. To meet various operating requirements, to handle various corrosive materials, NATIONAL offers lead-lined steel and cast iron pipe—as well as all-lead pipe.

NATIONAL LEAD is the leader in lead products. Its strategically-located plants and warehouses, its unexcelled sources of raw materials, its years of experience ... all contribute to the kind of service you expect from the leader.

So for lead pipe—or any other lead product—remember the leader is NATIONAL.

Reg. U. S. Pat. Off.

NATIONAL LEAD COMPANY

New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 8; Cincinnati 3; Cleveland 13; Dallas 2; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Co. of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Company, Limited)

FROM original idea to performance-guaranteed installation, each Chemico process is carefully tested and developed in these well-equipped laboratories and pilot plant.

On new processes, pilot plant or semi-commercial scale operations are conducted until they are fully proven. As a result, "growing pains" are radically reduced, proper construction materials can be selected and equipment sizes calculated for large scale commercial operation.

By means of these step-by-step, developmental methods, Chemico has given industry the drum-type, flash film and high temperature acid concentrators, the hot coke sludge conversion process, a new sulfur recovery process, economical plants for recovering alkylation spent acid and pickle liquor, and many other well-known and widely accepted processes.

Today, Chemico laboratory technicians and pilot plant operators in Linden, N. J. are busy proving out ideas that promise much for the future.

Extensive use of laboratory and pilot plant research is another important reason why Chemico plants are profitable investments.

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

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CABLES: CHEMICONST, NEW YORK

EUROPEAN TECHNICAL REPRESENTATIVE

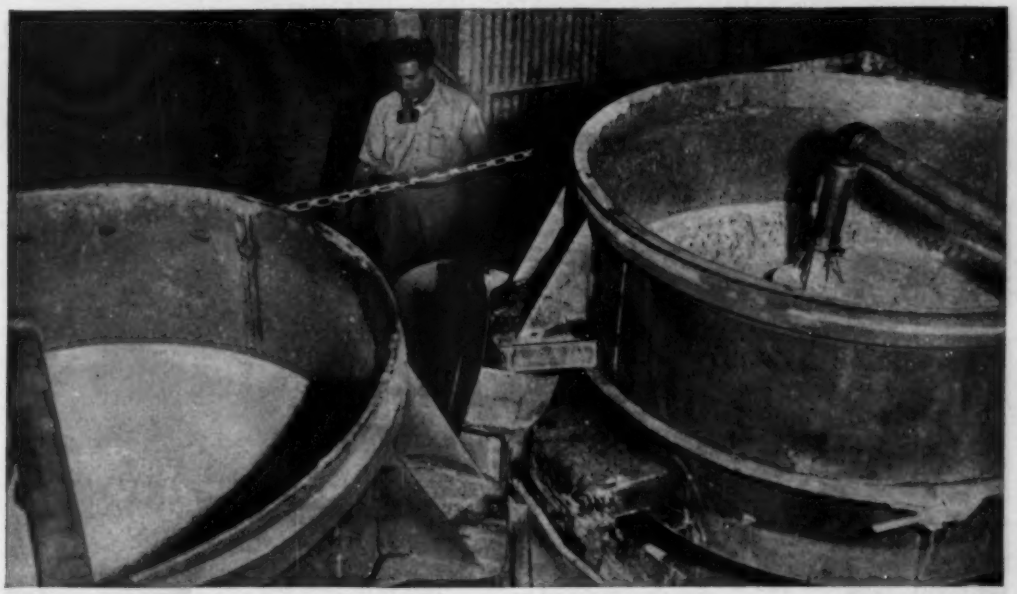
CYANAMID PRODUCTS, LTD., NORTH WEST WING, BUSH HOUSE

ALDWYCH, LONDON W.C. 2, ENGLAND

CHEMICO

Chemico Plants are Profitable Investments

CC 888



Shaking the bugs out of a new screening idea

When Southwestern Engineering Company, of Los Angeles, came up with the idea of a screen separator with "bumps *and* grinds"—bouncing *and* vibrating action—they knew they had something.

Something that might speed up sluggish separating processes tremendously. In oil, for example, where the "sluggard" is mud... in fruit processing where it's pectin, juices and purees... in ceramics where it's a silica-clay-talc-water slurry called "slip."

The idea was swell. But working it out, finding the right metal for the cylinders, was a lulu.

They'd try one. It wouldn't meet the acid test ...quite. And would contaminate some products ever so slightly, but ever so disastrously.

They'd try another. Tons of jiggling mix would eventually break its back.

Still another. The cylinders would keep splitting at the seams.

Finally, they tried Monel. And they were in. No more trouble, no matter how much machines were overloaded or over-speeded!

First to take advantage of this new Sweco development was Gladding McBean & Co.

They installed the two Sweco separators shown here to screen clay slip for their famous "Hermosa" wall and floor tile. And by so doing, they improved their product because they were able to use a finer clay . . . boosted production because they could handle slip with only 40% instead of 51% water (thereby saving about 35% on fuel costs in the subsequent drying)...and increased the life of the screen cloth from *4 days to 26 months!*

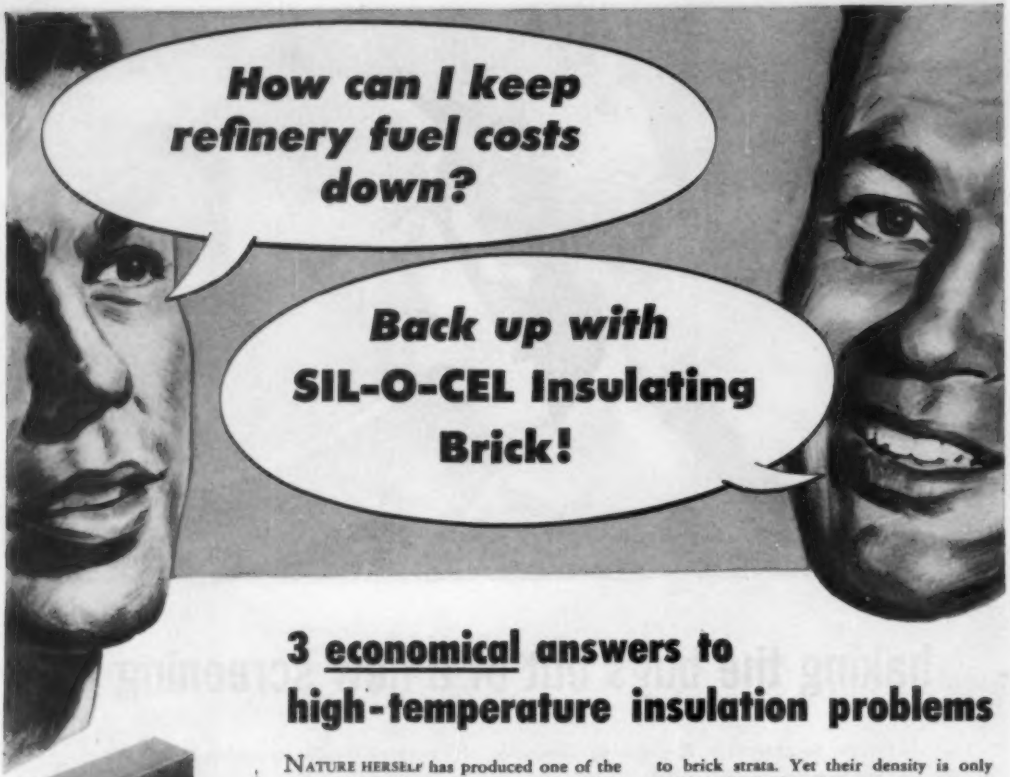
Now what about your metal problem?

Could one or another of the Inco Nickel alloys help solve it? Very possibly. Write us about it. Even though Nickel is being diverted to defense, we are ready right now to help you with ideas and suggestions for your present production and future planning.

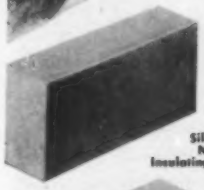
The International Nickel Company, Inc.
67 Wall Street, New York 5, N. Y.

NICKEL ALLOYS

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL "S"® MONEL • NICKEL • LOW CARBON NICKEL DURANICKEL® • INCONEL® • INCONEL "X"®



3 economical answers to high-temperature insulation problems


Sil-O-Cel Natural Insulating Brick

Sil-O-Cel C-22 Insulating Brick

Sil-O-Cel Super Insulating Brick

NATURE HERSELF has produced one of the most effective high-temperature insulating materials ever discovered—diatomaceous silica, from which Sil-O-Cel® Insulating Brick are made.

These insulating brick are used for back-up insulation behind fire brick or insulating fire brick linings in boilers, stills, stacks, reactor chambers, regenerators, heaters, flues, retorts, and other types of high-temperature equipment.

Sil-O-Cel Insulating Brick have excellent insulating qualities combined with high load-bearing characteristics and light weight.

Made in all standard shapes of the 2½ in. and 3 in. series, Sil-O-Cel Insulating Brick are produced in three basic types:

SIL-O-CEL NATURAL INSULATING BRICK
for temperatures to 1600F

Quarried directly from one of the world's purest deposits of diatomaceous silica, these insulating brick have a conductivity of only 0.79 Btu in./sq ft/F/hr at 1000F mean temperature, with heat flow perpendicular to brick strata. Yet their density is only 30 lb/cu ft. Cold crushing strength, 400 psi.

SIL-O-CEL C-22 INSULATING BRICK
for temperatures to 2000F

Ideal where high load-bearing properties are needed, this type of Sil-O-Cel is calcined, and has a cold crushing strength of 700 psi. Conductivity is 1.88 Btu in./sq ft/F/hr at 1000F mean temperature. Density, 38 lb/cu ft.

SIL-O-CEL SUPER INSULATING BRICK
for temperatures to 2500F

A calcined insulating brick for unusually high temperatures. In many cases, it is also possible to save on construction costs by reducing the thickness of fire brick or insulating fire brick when backed with Sil-O-Cel Super Insulating Brick. Conductivity is 1.95 Btu in./sq ft/F/hr at 1000F mean temperature. Density, 40 lb./cu. ft. Cold crushing strength, 300 psi.

For further information, write to Johns-Manville, Box 290, New York, N. Y. In Canada, write 199 Bay St., Toronto 1, Ont.

JOHNS MANVILLE JM PRODUCTS **Johns-Manville** *first in* **INSULATIONS**

Pre-solve Pipe Suspension Problems...

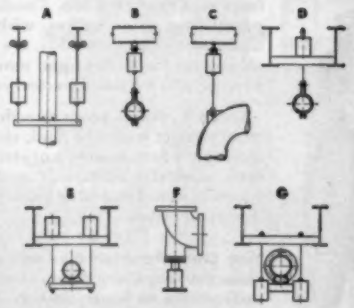
with

Grinnell Pre-engineered Spring Hangers

- Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes.
- Precompression* assures operation of spring within its proper working range where variation in supporting force is at a minimum.
- Compact—minimum headroom made possible by precompression*.
- Guides prevent contact of coils with casing wall or hanger rod and assure continuous alignment and concentric loading of spring.
- All-steel welded construction meets pressure piping code.
- 16 sizes available from stock — load range from 74 lbs. to 9000 lbs.
- Easy selection of proper sizes from simple capacity table.
- Installation is simplified by integral load scale and travel indicators.
- Unique swivel coupling provides adjustment and eliminates turnbuckle.

**Precompression is a patented feature.*

TYPICAL APPLICATIONS

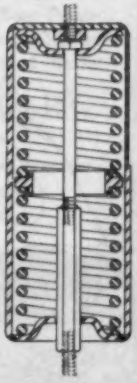


(A) Rod threaded to top cap (B) Furnished with single lug (C) Two lug style (D) Top adjusting (E) Adjustable top and bottom (F) For floor support (G) Trapeze assembly.

FOR LESS VARIATION IN SUPPORTING FORCE — FIG. 98

Fig. 98 is an adaptation of Grinnell's popular spring hanger, Fig. 268. It consists of two springs arranged in series within a single casing. A centering guide insures the permanent alignment of the spring assembly.

Fig. 98 has half the load deflection rate, and double the total working range of Fig. 268. Its 16 spring sizes accommodate loads from 74 lbs. to 9000 lbs. — but with a total working range *up to 5 inches!* Fig. 98 comes in the same seven types as shown for Fig. 268. Design details for identical types and sizes are the same for Fig. 98 and Fig. 268.



GRINNELL

WHENEVER PIPING IS INVOLVED

GRINNELL COMPANY, INC., Providence, R. I. Warehouses: Atlanta • Billings • Buffalo • Charlotte • Chicago Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach • Los Angeles • Milwaukee • Minneapolis • New York Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

piping upkeep *costs more* now!

Crane Alloy Cast Iron Gate Valve, 18-8 Mo. trimmed. 200 Pounds W.O.G.

You'll spend less for it with Dependable Quality

CRANE VALVES

. . . That's why more Crane Valves are used than any other make

◀ High Corrosion Resistance at Low Cost

Crane No. 14477 Alloy Cast Iron Gates give excellent service where "all-iron" or "brass trimmed" valves fail, due to corrosion of seating surfaces. Body rings, stem, and disc-faces are Crane 18-8 Mo. Conditions permitting, these valves, with low nickel alloy cast iron body, are ideal substitutes for hard-to-get, more expensive, all 18-8 stainless steel valves.

O.S. & Y. design keeps stem threads from contact with line fluid; straight through ports assure unrestricted flow, minimize turbulence and corrosive action. Extra-long guides keep disc travel true.

Your Crane Representative will gladly show you why Crane Valves give better performance at lower ultimate cost—why you should insist on Crane Quality.

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General Offices:
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VALVES • FITTINGS • PIPE • PLUMBING • HEATING

GRAVER FABRICATIONS

Three of the Graver-built vessels ready to leave East Chicago plant on long trip to England via New Orleans.

for Europe's Largest Refinery

● For the mammoth new Esso Petroleum refinery at Fawley, England, Graver's East Chicago and Catasaqua plants fabricated a number of API tanks and vessels:

Slurry Settler Drum
Condensate Surge Tank
Explosivity Convector
Heavy Cycle Gas Oil Stripper
Boiler Blowdown Drum
Hydraulic Oil Accumulator
Catalyst Gas Compressor Suction Knockout Drum
Light Heating Oil Stripper
Steam Disengaging Drum
Primary Fractionator Distillate Drum
Hydraulic Oil Storage Tank

Constructed by Foster Wheeler Corp. for Standard of New Jersey's affiliate, Esso Petroleum Co. Ltd., this plant will eventually be capable of processing 130,000 b/d of crude.

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK • CHICAGO • PHILADELPHIA • WASHINGTON
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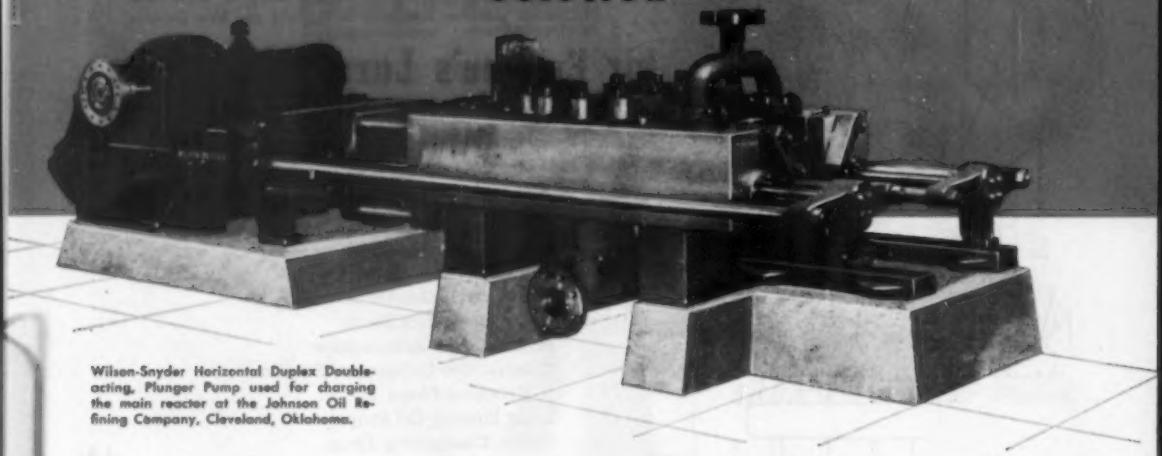
GRAVER

7 out of 13 refiners

...installing UOP's PLATFORMING Process selected



Wilson-Snyder Horizontal Duplex Double-acting, Plunger Pump used for charging the main reactor at the Johnson Oil Refining Company, Cleveland, Oklahoma.

WILSON-SNYDER PUMPS

In just ONE YEAR . . . the PLATFORMING Process, discovered and developed by Universal Oil Products Company, has proved its merits, and THIRTEEN REFINERS desirous of improving the octane characteristics of straight run and natural gasolines, and producing light aromatic hydro-carbons, have contracted for platforming installations.

A Wilson-Snyder horizontal duplex outside end-packed double-acting plunger-type pump was selected for charging the main reactor in the initial commercial installation of this process at Old Dutch Refining Company, Muskegon, Michigan.

And because of its dependable performance, seven of these thirteen refiners, to date, have specified the proper Wilson-Snyder Pumps for their respective platforming installations.

We're proud of the fact that Wilson-Snyder Pumps are being selected for so many of these installations . . . and invite your Refinery-Pump inquiries. Your local "Oilwell" Representative will expedite the preparation of detailed recommendations to meet your requirements.

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"OILWELL"

TRADE MARK

UNITED STATES STEEL

PETROLEUM
REFINER

The LOOK BOX

Petroleum Refiner Process Issue

THIS IS THE 1951 Process Issue of the PETROLEUM REFINER. Each year at this time a special section is devoted to a review of processes in petroleum refining. In some years, for example 1949, the process section has been in the form of a process encyclopedia, including a short writeup of most of the refining processes in current use. However, in 1950, and now again in 1951, the process section is devoted chiefly to processes of high current interest or in which there has been recent significant developments. This approach is necessary because of the considerable activity in certain fields of refining processing.

It is interesting to note a revival of interest in catalytic alkylation. For the past several years there has been little activity in this field, and most of the war-time alkylation units were shut down or revamped for other purposes. But now, with the current program of national preparedness and a new demand for grade 115/145 aviation fuel, alkylation is again a process of major importance. Both sulfuric and hydrofluoric acid alkylation processes have been improved and simplified, and a large number of new plants are being planned or built.

Again this year, there have been significant developments in catalytic cracking. Designs have been simplified and operation improved, so that the new units offer savings in both investment and subsequent operating costs.

A field of particularly high activity is catalytic reforming, with the announcement of four new competitive processes this year, in addition to the one announced last year. This high interest in catalytic reforming extends in two different directions: the reforming of straight-run naphthas to make high-octane motor gasoline, and the reforming of selected naphtha cuts to make aromatics, sorely needed. In connection with the latter, there have also been considerable new developments in processes for the separation and purification of benzene, toluene, and other aromatics.

The chemical industry is looking more and more to petroleum as a source of chemical building blocks. In addition to benzene and aromatics, ethylene is in high current demand, and many new plants are being built to make this important chemical intermediate from petroleum hydrocarbons. This in turn directs further attention on the light hydrocarbon separation processes.

These and other recent processing developments are covered in the current process section, beginning on page 145.

The Rich Man's Oil

BIG BUSINESS, and especially the oil business, is frequently the target of unfair criticism. These complaints usually come from those who do not understand that the American way of life

Top-of-Page Photo—Ablaze with light, Plymouth Oil Company's gas processing plant in the Benedum field, Upton County, is quite a nocturnal landmark for West Texas travelers.

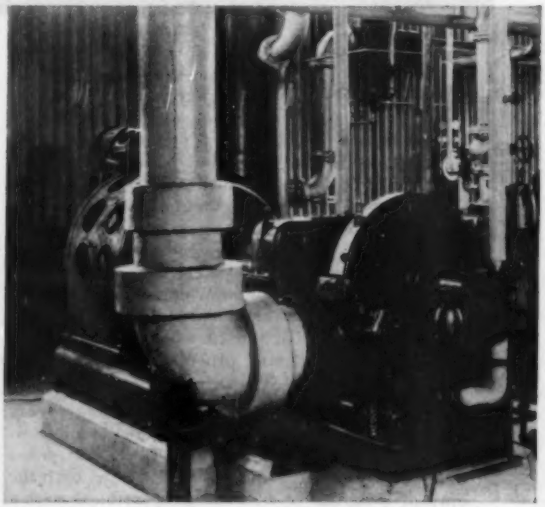
WHY STANDARD DP TURBINE DRIVES FIT ALMOST ANY APPLICATION

Here's a turbine designed by turbine users. It incorporates the features asked for by hundreds of operators interviewed in an exhaustive survey. They told General Electric they wanted a mechanical-drive turbine that would fit many types of applications—continuous process, standby, indoor, outdoor, equipment drive, generator drive, etc.

The DP answers these varied requirements with special features that are included as standard parts. For instance, you get hydraulic governing to meet critical accuracy requirements, totally enclosed construction that allows installation in hazardous atmospheres, pressure lubrication for dependable, continuous operation. These advantages are included at no extra cost—the DP is priced as a standard.

If you have steam available, the DP turbine can work profitably for you. You'll discover how its standard design gives you wide application flexibility, makes possible real savings in maintenance costs. The DP's operating record proves its reliability when there's a tough job to be done.

OUTDOOR INSTALLATIONS—No need to make special modifications when you move a DP out of doors. Totally enclosed governing system operating in its own oil atmosphere eliminates possibility of rusting or corrosion. You can operate a DP in hazardous atmospheres. Positive acting, non-sparking emergency governor protects the DP turbine against overspeed.



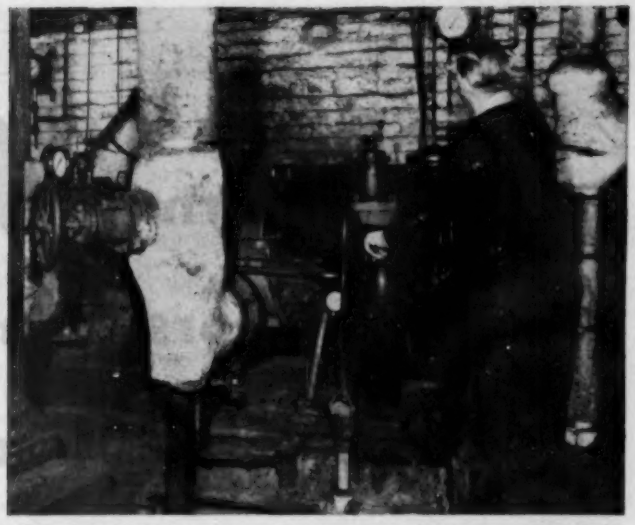
PRECISION GOVERNING—accurate enough for generator drives—is yours with the DP's hydraulic system. Regulation is 6 per cent with a 30 per cent range of speed adjustment. For process governing, regulator control is available.

Ask your General Electric representative for full details about the DP mechanical-drive turbine, or write for bulletin GEA-4955. General Electric Company, Schenectady 5, New York.

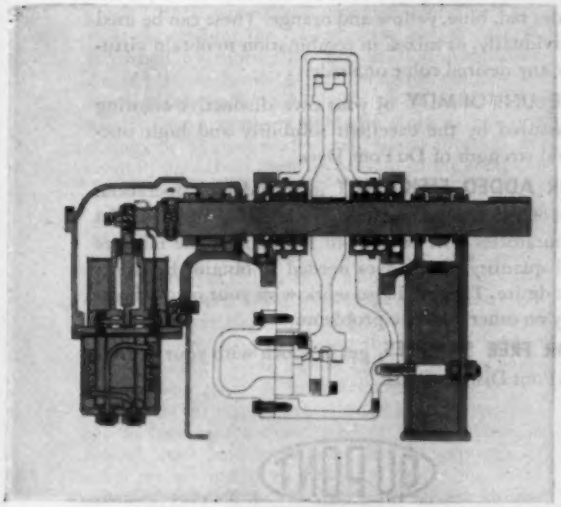
GENERAL ELECTRIC

252-50

MECHANICAL-DRIVE TURBINES



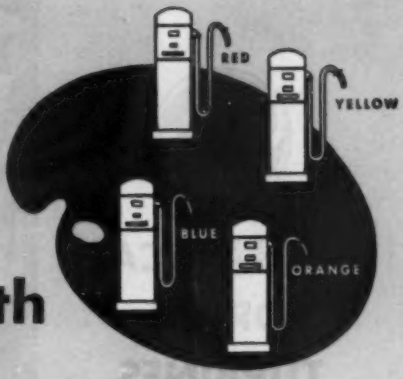
DEPENDABILITY is built into the DP. Positive lubrication through automotive-type bearings adds years to the life of the turbine. Special steel nozzle plate, self-lubricating graphite packings, and Monel-sprayed shaft are examples of design features that spell reliability.



APPLICATION FLEXIBILITY As the shaded parts in the diagram illustrate, most DP parts are identical on all frame sizes and ratings. In this way, you can adapt a DP for different job requirements with only minor changes. A different nozzle plate gives you a new horsepower output. A change in governor gears provides a new speed range. DP's are rated from 10 to 1200 HP and 1000 to 5000 rpm, and with slight modification, can deliver up to 2000 HP and 10,000 rpm. During a change in plant operation, the DP's flexibility will save you money.

EASY MAINTENANCE Because most parts are interchangeable on all models, spares can be stocked at low cost. A spare parts kit, containing 91 items, can be obtained with the turbine. This simple method of stocking spares lowers maintenance costs and provides protection for several DP's in your plant. All models, regardless of frame size, horsepower, or speed ratings, have identical shaft height, keyways, and coupling fits. Thus, installation problems are simplified; you can move these center-line supported units from job to job without a custom line-up.

Assure uniform gasoline colors with readily soluble Du Pont Dyes



TELLING A STORY IN COLOR, this recording spectrophotometer measures the strength, shade and brightness of colors obtained with Du Pont Gasoline Dyes. To assure refiners of uniform tinctorial properties, Du Pont Gasoline Dyes are carefully checked by instruments like this.

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All too frequently Big Business does not make much of an effort to defend itself, or to enlighten the public to the essential facts of our American free-enterprise economy. However, the June 1951 issue of *The Sohioan*, of The Standard Oil Company of Ohio, contains an excellent example of how these economic facts can be brought to light effectively.

In this article, E. A. Jacquet answers a question raised by the columnist Tom Stokes, "Why doesn't Congress tax the rich man's oil?" In answering, Jacquet first notes that the question slyly implies that a) the oil in this country belongs to the rich, and b) that the oil industry has somehow up to now escaped the attention of the tax makers (!) and is not carrying its share of the nation's tax burden.

Both of these implications are of course untrue. With respect to the oil belonging to the rich, Jacquet observes that "about 10,000 persons work for Sohio, but more than 22,000 own it and depend upon its stability and success to assure safety for their savings. No single individual holding shares in this company owns as much as 1 percent of its stock." Such widespread ownership of stock prevails throughout the oil industry, and, in fact, oil is owned by more than one million Americans. Among these ranks of oil company owners are representatives of all walks of life, including mostly just average people who work at all sorts of jobs or live on modest retirement incomes derived in part from their ownership of oil company stocks.

Jacquet points out that "Today American motorists get far better gasoline and other oil products at prices no higher, and in some cases lower (except the tax) than they paid 25 years ago. By way of contrast, today's taxes on gasoline are 177 percent higher than they were in 1926. Taxes on the typical motor vehicle and the gasoline it used last year added up to almost as much as the average motorist paid in federal income taxes."

"In a recent typical year United States motorists had to fork over a grand total of *$3360 million* in federal, state, and local taxes for the privilege of using the oil industry's products. Today, on every gallon of gasoline they buy, car owners are already paying government (federal and state) an average tax amounting to *33 percent of the retail price!*"

In the light of these facts, it is difficult for us to understand how anyone can ask, "Why doesn't Congress tax the rich man's oil?"

Energy In Year 2000

THE CONSUMPTION of energy in the United States by the year 2000 will be equal to the current consumption of the entire world, or about 25 trillion horsepower-hours per year, G. W. Gleeson, Dean of the School of Engineering and Industrial Arts at Oregon State College, declared recently. In the light of this picture, he urged that real consideration be given to the development of the continuous sources of energy, water power, energy from vegetation (directly and indirectly), solar energy, wind power, earth heat, tidal power, tropical waters, and the heat pump.

With the exception of hydro-electric power, our energy now comes from discontinuous sources, the fuels of which are finite in amount, he said. Although there are ample and available sources of energy to provide for our immediate requirements, he declared, the cream has already been consumed. Within the coming century, the fuel situation as we now know it will not exist, he predicted. He listed among the discontinuous sources of energy: coal, petroleum, oil shales, natural gas, and atomic energy.

Even the most optimistic estimates lead to the conclusion that nuclear fission as a source of energy will be a highly specialized one having definite limitations and a probably transitory existence comparable to that of petroleum, Dean Gleeson said. He called for periodic inventory of our energy resources and urged that our fossil fuels be conserved by substitutions of one discontinuous source for another and continuous sources for the discontinuous ones. "In addition to development of new sources of energy, we have much to accomplish by way of improvement in use of currently developed sources through higher efficiencies of utilization, transport, and conversion," he said.

Other points made by Dr. Gleeson were:

1) In the interest of future generations as well as in the interest of true conservation, we should hoard our fossil fuels wherever possible.

2) There are distinct possibilities of greater development and use of continuous sources of energy probably within 100 years.

3) Energy sources, limitations, and locations may well influence our living patterns through change in architectural design, industrial locations, comparative price of fuels, and the development of more integrated energy systems.

4) We should be willing to pay a premium now in terms of research and development to effect conservation of our least adequate in amount, but most useful in form sources of energy. Such research as shale oil recovery, liquid fuels from coal, and utilization of vegetable wastes should continue to receive adequate public support.

5) We should direct conservation effort preferentially to areas of largest consumption, such as space heating and provision of process heat.

6) In the public interest, we should eliminate wasteful processes where conservation could be effected by substitution even if such substitution results in a temporary economic disadvantage.

Cat cracking calls for the "year-round" service of

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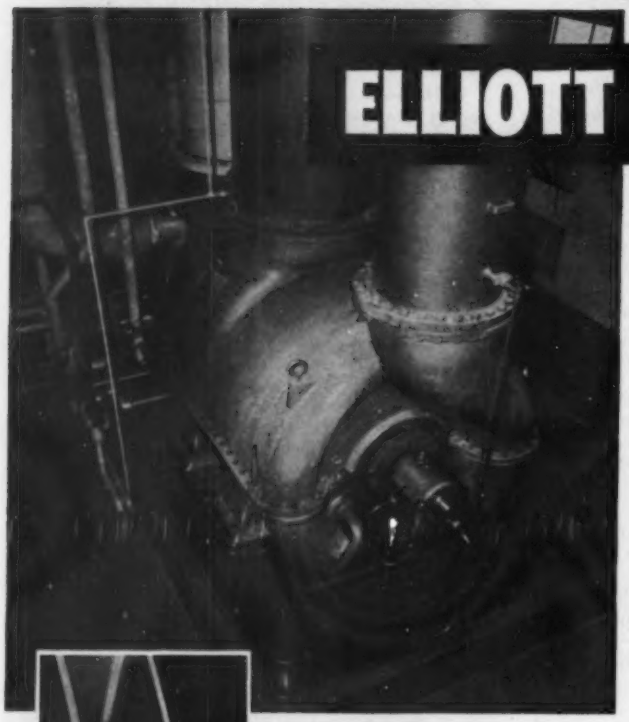

CONTINUOUS AND reliable performance is an established characteristic of Elliott centrifugal blowers. This is proven in numerous modern refineries where large quantities of air are required for conveying and regenerating catalyst.

The blower installation pictured is typical. Serving an important mid-west refinery, it is rated at 30,000 inlet cfm, compressing air to a discharge pressure of 26 psig. Day and night this blower is driven at 4750 rpm by an Elliott direct-connected 3140-hp condensing steam turbine.

In recent months an Elliott blower in cat cracking service broke all records for continuous operation —677 days. The previous non-stop record of 610 days was also held by an Elliott blower. Performance like this spells *profit*.

WELDED IMPELLERS are one of the many reasons why Elliott blowers are getting ever-increasing acceptance for process work. Note the smooth contours, heavy blades, and generally rugged construction (as compared to conventional riveted impellers). These impellers are completely homogeneous and can be made of any weldable material having reasonable mechanical strength.

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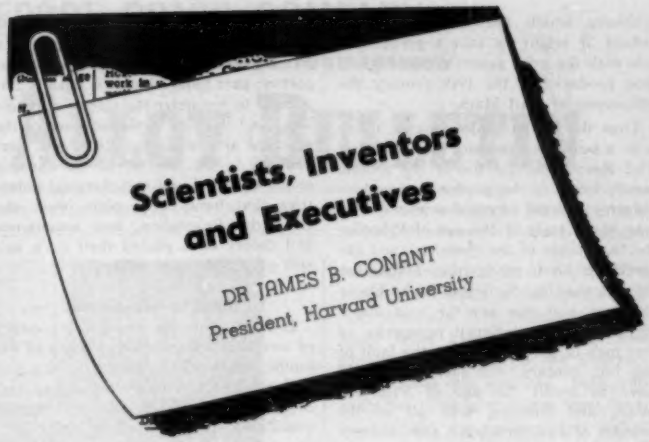
Elliott Blowers—*the heart of the cat cracker*



ALL of us who are gathered here, share one prejudice in common. We believe that scientific research is of supreme importance. That being the case, we rejoice at each new addition to the research facilities of the nation. In particular the Du Pont Company is to be congratulated on the dedication of its new laboratory. To attempt to relate the successful pioneering of the Du Pont Company in the field of American chemical research would be the equivalent of carrying coals to Newcastle. But a word of appreciation is due this company on behalf of the academic world of science.

The farsighted policy of the management of the Du Pont Company as regards scientific research has had a beneficial influence both direct and indirect on the whole development of chemistry in the United States. All those who are concerned with the application of science to industry must, of course, applaud what has been done here in Wilmington in this century. But even those academic people who are interested only in theoretical chemistry must be grateful to Du Pont for the wise and generous support of academic chemists throughout the country. Officers of the company are to be thanked for their continuing devotion to the progress of American chemistry.

Mentioned at the outset was a certain prejudice that many of us share in common. Perhaps instead there should have been stated the premise we all accept: that is, that the advance of science is of the utmost importance. Some of us hold this view because we are deeply concerned with science as an ever-growing fabric of facts and theories; others, because of the application of science to human welfare. Let us explore these two different approaches to a common goal—the advance of science—and relate both to government on the one hand and modern industry on the other.

Starts in 1780

The story will start in Birmingham, England, in the 1780's and end in Wilmington, Del., in the 1950's. Presented are three characters as the prototypes of the scientist, the inventor, and the executive—Joseph Priestley, James Watt, and Matthew Boulton. Let us contrast their respective roles in the society of their day with that of their intelleectual descendants in this century. And since the world is divided by a heavy iron curtain, the comparison must include a contrast between a land of freedom and one under the rigid rule of a totalitarian philosophy that dominates both thought and action.

As one surveys the history of science and technology, the last third of the 18th century stands out as being a revolutionary period. Reference is not to the American Revolution nor to the French Revolution, but rather to that rapid growth in industry which has come to be known as the Industrial Revolution. Also in mind are the series of events so significant to all chemists that they are often designated the chemical revolution. The names of Priestley, Cavendish, and Lavoisier are associated with the discovery of oxygen, the composition of water, and the development of a clear theory of combustion.

Priestley, Cavendish, and Lavoisier were all amateurs. That is to say none of them received any compensation either for his research activities or for teaching science. The first was a dissenting minister, the second a wealthy recluse, the third a Frenchman of affairs. In general, the great scientific advances of this period were made by amateurs as they had been from the 17th century on. Not until we reach the second and third quarters of the 19th century do we find that those who were most prominent in advancing science were devoting their entire time to scientific activities by which they earned their living. Today, the scientific amateur, in the sense that the word is used here, has all but disappeared. The significance of this point will be stressed later.

THESE interesting views by an outstanding American scholar, are taken from an address which Dr. Conant delivered recently at Wilmington, Del., on the occasion of the dedication of the expanded experimental station of the E. I. du Pont de Nemours & Company. Dr. Conant is placing his bet on freedom and a reading of the entertaining account which he relates makes the thoughtful man wonder that there should be any other prophecies.

James Watt was initially a lone inventor. The story of his difficulties with the improvement of the Newcomen steam engine is too familiar to warrant retelling. The point here is that he was a self-starting, independent inventor. But unless he had been fortunate enough to join forces with a man of exceptional business skill, Matthew Boulton, his mechanical ingenuity and scientific insight might well have proved to be of no avail. Without the businessman, the executive who was also an innovator, Watt would not have been a key figure in the Industrial Revolution.

A Chain Reaction

The Industrial Revolution was in one respect like a chain reaction. Invention fed on invention. Watt and Boulton, you may recall, turned to an inventive ironmaster, John Wilkinson, for the boring of the cylinders for their engine. And it is probably not too much to say that the success of Watt's engine as compared with those of his predecessors and rivals was the consequence of an invention of Wilkinson—a new machine for the accurate boring of cannon. Then Wilkinson turned around and bought one of the new steam engines to operate the blast of his foundry furnaces and later the mechanical equipment. The iron industry and the use of steam progressed together; one invention enabled another to be made. As a consequence the age of iron and steam grew to maturity in England before the 18th century was over. Together with the accompanying changes in the textile industry and in transportation, we have the phenomenon we called the Industrial Revolution. The impact of this Revolution on the economic life of Great Britain produced social and political

problems which are not yet solved. Indeed, it might be said a preoccupation with the grim aspect of these problems produced in the 19th century the philosophy of Karl Marx.

Thus the Soviet philosophy of today is in a sense one product of the Industrial Revolution. So too is the atomic bomb; for it is the product of modern industry and the physical sciences. One may easily trace to the age of Priestley the beginnings of the chemistry and engineering that made the Manhattan Project possible. So if you like to blame the past, you may say the twin major threats to the continued prosperity of free men in this century are the fault of the 18th century. But then you would have to credit the age of Priestley, Watt, and Boulton with all of the benefits of modern science and industry. The truth of the matter is summed up in that phrase of Emerson's: "There is a crack in everything God has made." And today we are painfully aware of two cracks in the foundation of the world which came to light in Great Britain 150 years ago.

But these involved thoughts, which to some may seem fantastic, will be pressed no further. For my purpose is to consider the problems of how the present descendants of Priestley, Watt, and Boulton are to get along together. (The word "descendant" is used metaphorically, of course). Now it so happens that Priestley, Watt, and Boulton were close friends. John Wilkinson, the inventive ironmaster, was Priestley's brother-in-law; Josiah Wedgwood, the inventive potter who founded the great potteries, was likewise of this circle of scientists, inventors, and innovators who lived in or near Birmingham in the closing decades of the 18th century. They shared a common interest in scientific matters but, and this is important, the technological advances of that time were made with little or no benefit of science.

The element of theory, of scientific generalization was almost entirely lacking. How could it be otherwise with chemistry or metallurgy? For remember, the role of oxygen in combustion was in process of discovery, the composition of steel was unknown, the atomic theory only a speculative idea as it has been for generations, and heat was a caloric fluid. Wedgwood revolutionized his pottery; Wilkinson vastly improved the manufacture of cast iron by purely empirical procedures. Indeed, the advances of technology, including the chemical and metallurgical technology of the entire 18th century and much of the early 19th, was by cut-and-try methods. The invention of the Leblanc soda process is a case in point.

It is of importance to recognize that in the technical progress of even the last 200 years pure empiricism has played a tremendous role. It still plays an important part today. But it is equally important to recognize the role of scientific ideas and theories in the advance of the practical arts in the last 100 years, particularly in the last 50. In the changes in the chemical and metallurgical industries that have taken place since the Industrial Revolution, both empiricism and theory have played their part, and still play their part today.

Blend in Laboratories

If you go into the research laboratory of any chemical industry today and examine the work in progress, you will find a blend of empiricism and of theory. For example, to the extent that conditions are controlled by buffer solutions and pH measurements, it could be said one was operating with little empiricism. To the extent that a given concentration or temperature or presence of a certain metallic ion has been found by experience to give a good yield in a certain reaction, one is dealing with nearly as much empiricism as is a skillful cook. The gradual lowering of the degree of empiricism in many industrial operations has gone hand-in-hand with much highly successful empirical work. But the most successful penetration of theory into practice has occurred within the lifetime of many of us.

The typical inventor was essentially an empiricist. Indeed, we used sometimes to speak of the cut-and-try methods of experimentation as Edisonian methods. Therefore, as theory developed in physics and chemistry and penetrated into practice, as the degree of empiricism was reduced in one area after another, the inventor was bound to disappear. Today the typical lone inventor of the 18th and 19th centuries has all but disappeared. In his place in the mid 20th century came the industrial research laboratory and departments of development engineering. There is no need to underline the significance of the change from the point of view of the public. The triumphs of applied chemistry, for example, of the last 20 years are the product not of empiricism but of the application of theory to practice.

An Important Link

There are several interesting points to be noted in connection with this transformation of the process of industrial innovation. The first is that the progress of the industrial arts has become linked very closely to the advance in theoretical science. Priestley, Watt, Boulton, and Wedgwood were close friends interested in experimentation, but there was little or no connection between the "philosophical experiments" of Priestley and the practical experimentation of the inventors. They were both manifestations of the same restless curiosity, but the time was not ripe for the sciences of physics and chemistry to influence industrial practice. Boulton, the executive, and Watt, the inventor, were interested in what Priestley was doing; Watt even suggested an interpretation of some of Priestley's experiments that give him some claim to have discovered the composition of water. Yet as far as their work as inventors and innovators was concerned, Priestley, Cavendish, and Lavoisier might experiment or not. In contrast, consider the enormous amount of scientific knowledge which will be brought to bear on practical problems in one way or another in this new laboratory.

The second point is that the revolutionary advances in theoretical science were made very largely by amateurs. And clearly almost all the great advances in industry until this century were made by the independent inventor. These men have passed. They have no intellectual descendants. Will their 20th century equivalents—the professional scientist, the applied science laboratory, the engineering group—be able to carry on? Why, of course, some of you will say. Look at what has happened in the last 30 years. We have just referred to the startling advances in applied chemistry. Look at the electrical industry; the new way of advancing science, pure and applied, is far better than the old. Perhaps; but it is too soon to draw definite conclusions. There is such a thing as momentum in human affairs as well as in physics. And we of the mid-20th century have been moving forward to a considerable degree because of the momentum accumulated in the days of the amateur and the lone inventor. At all events, there is sufficient doubt about the ability of the new ways to be substituted for the old for us to examine the problem with some care.

Few would deny that it is relatively easy in science to fill in the details of a new area, once the frontier has been crossed. The crucial event is turning the unexpected corner. This it is not given to most of us to do. If you want advances in the basic theories of physics and chemistry in the future comparable with those of the last two centuries, then it would seem essential that there continue to be people in a position to turn unexpected corners. By definition the unexpected corner *cannot* be turned by any operation that is planned. There are plenty of recognized corners in science, pure and applied, that have been turned by concerted attack mapped out ahead of time. That these operations will continue there is no doubt. But whether there will continue to be a favorable cultural atmosphere for the exceptional

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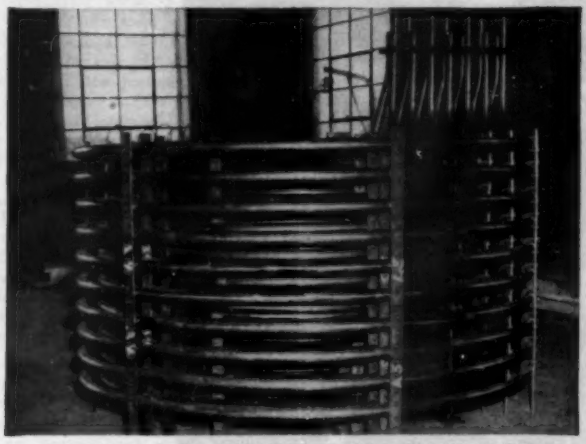

Heating and cooling coil made from Stainless Steel-Cupro Nickel Duplex Tubing

Stainless Steel-Cupro Nickel Duplex Tube for Heating and Cooling Coil

Controlling the temperature of various chemical reactions is often a major problem in the chemical industries. Some heating is required in the early stages to help activate these reactions. However, as soon as it is under way heat is generated so rapidly that it must be cooled to the proper temperature in order to produce a satisfactory product and prevent decomposition of materials. In addition, the presence of various acids in the solution is often too corrosive for ordinary materials.

Stainless Steel Coil Failed

The coil illustrated above was originally constructed from stainless steel tubing 2¼" O.D. x .218" wall thickness. Ordinarily, stainless steel would have been a suitable material of construction in the particular chemical service involved.

On the other hand, although stainless is highly resistant to many corrosive elements, it is vulnerable to stress corrosion cracking, particularly in the presence of chlorides. Failures were encountered in the stainless coil primarily from the inside surface of the tubing in the form of stress corrosion cracking due to the high chloride ion found in the raw water used for cooling.

Stainless Steel-Cupro Nickel Duplex Coil Effective

Since most of the copper-base alloys are resistant to cracking and corrosion from water and brine, it was decided to solve this problem by constructing the coil from Duplex tubing with cupro nickel to the circulating water side and stainless steel to the product side. Aside from its superior corrosion resistance the Duplex tubing has approximately 25% higher heat transfer rate than straight stainless steel.

From a construction standpoint, the coil is more difficult to fabricate than the straight stainless type. To obtain the required fast cooling rate, a large surface area must be presented to the liquid to be cooled. Furthermore, a rapid change in circulating water must be effected. Consequently, this special coil was designed with seven separate coils nesting together. The outer coil is approximately 8 ft. in diameter and is made from 262 ft. of tubing. The inside coil, which is the smallest, is approximately 3 ft. in diameter and made from 158 ft. of tubing. The Duplex tubing used for the construction of this coil was 2¼" O.D. and both the outside stainless steel component and the inside cupro nickel component had a wall thickness of 0.109".

Joining Duplex Tubing by Heliarc Welding

An ingenious method was used to join the 24 ft. lengths of Duplex tube to make the continuous length required for each of the coils. To protect the cupro nickel from the corrosive products, it was necessary to join stainless steel to stainless steel and cupro nickel to cupro nickel. To prevent contamination of the stainless weld with copper, a special low-carbon content Type 304 stainless tubing was used for the outside component of the Duplex combination. First, the outside layer of stainless steel at the ends to be joined, was cut back approximately ½". Then the cupro nickel ends of the two tubes were butted and welded with a special welding rod by the heliarc welding process. Then the outside layer of stainless steel was built up by heliarc welding.

The above represents an extreme case of construction involving the welding of Duplex tubing into long lengths, coiling, etc. Most applications for Duplex tubing require straight lengths that can generally be fitted into the headers of condensers and heat exchangers similar to single wall tubing. Unless conditions are exceptionally severe, requiring cupro nickel for example, most applications may use copper, Admiralty, brass or aluminum bronze towards the circulating water side. The increasing use of Duplex tubing in an ever widening list of applications attests its superiority over single wall tubing for solving difficult corrosive conditions and for reducing costly maintenance. (7153)

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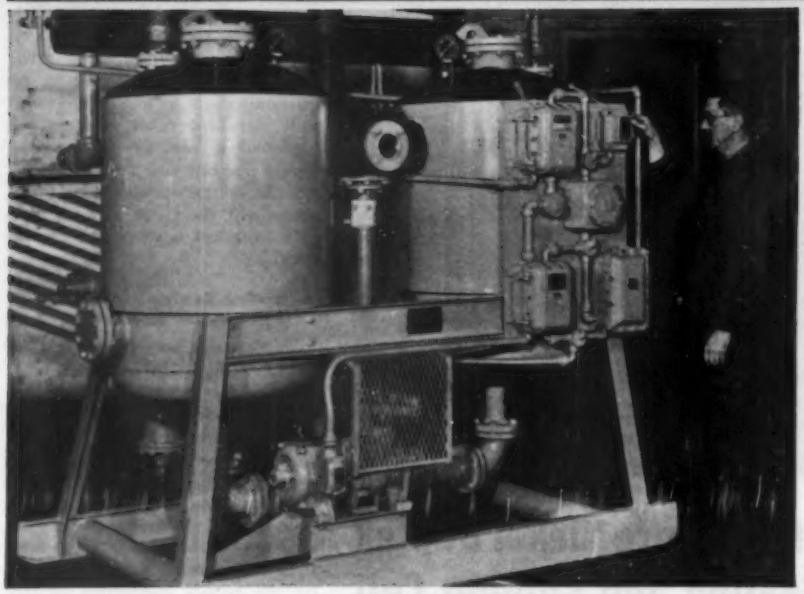

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man with really new ideas in science there are some doubts.

Such a man we will call the uncommitted investigator. Such a person was Priestley, Lavoisier, Faraday, and Pasteur (in his early years). They could investigate what they pleased when they pleased, break off a research at any point. They were as free as the wind because they had no program except the ever-changing one in their own heads. Contrast such research men with the investigator today in a university or a research laboratory who is tied to a program, perhaps, of his own making. But in part because of the vast capital investment in the equipment (a cyclotron for example), in part because of the source of funds, he is morally bound to carry through a project. This may be in "pure" science, in basic research, or for a definite practical object. That does not matter; the contrast is between the uncommitted investigator on the one hand and the director of a research program on the other.

Indeed, the distinction made seems to be more significant than the distinction between pure and applied research. Therefore, the analysis of the advance of theoretical science to the problem of the industrial research laboratory is carried over. For the inventor who has disappeared was like the scientific amateur an uncommitted man. He was guided entirely by his own ideas—and sometimes they were wild ones—veritable will-o'-the-wisps; like an old-time prospector he played a lone hand.

Looking at Social Changes

Now there are always at least three ways of looking at drastic social changes. One is to say this is a clean break with the past; forget history, start afresh. Another is to say let us recognize the altered situation but try and keep the elements from the past that experience seems to have shown to be essential ingredients of a successful undertaking. Still a third is to say the change is bad, completely bad, and nothing good can come of it. The last is the attitude of the reactionary, the second of the progressive, the first of the radical. It is not without its interest that as regards this altered situation of the scientist and inventor we can clearly see today these three attitudes exemplified, particularly the first and second. The radical approach in action is to be found in the Soviet Union though some proponents of almost the same point of view can be found in the free nations. The progressive approach is the one for which I speak.

The key man at this point in the discussion is the third member of my trio—the executive—the modern equivalent of Matthew Boulton. In a given area of industry he must organize a vast amount of research—programmatic research. That goes without saying. But in the process he must somehow continue to produce the equivalent of the lone inventor; he must have some individuals in his outfit who will be almost fancy free. It is not proposed to tell him how to do it. There may well be more than one successful method. However, society would be well advised to see to it that the technological situation is so loose-jointed that the skills of different groups in playing the role of inventor may be pitted against each other. Looking at the matter solely from the point of view of furthering technological advances, it would seem essential not to have a monolithic structure, a close-knit national organization either in a practical art or in science.

Rivalry a Spur

By and large, in spite of the heavy pressures driving academic men down the road of programmatic research, the American people will be wise enough to support the uncommitted investigator in science. There will be sufficient rivalry within most industries to insure adequate explorations of various procedures for keeping the spirit of invention at a high level. Whether this will result in as much progress in science and technology as in the recent past no one can say, but by and large the progressive attitude towards the new situation can be expected to prevail in the United States.

Great Britain and the European continent are another story and neither comments nor predictions are ventured here. As to the other side of the iron curtain there can be no doubt. There you have a full-fledged acceptance of the radical point of view about the altered nature of research and invention. With a blare of Marxist trumpets science is being put to work for the benefit of the "anti-bourgeois revolution." The Soviet interpretation of the philosophy known as "dialectical materialism" embraces not only politics and economics but every branch of knowledge. There is a party line in biology, in theoretical physics, even in philology!

A leading Russian geneticist, a member of the Moscow Academy of Science, published just a year ago a defense of what has been going on in biology in Russia. The charge has been made, he says, that in the Soviet Union science no longer bears a "supranational character," the statement has been made "that—a great scientific nation has repudiated the universal and supranational character of science." "This is not true," he declares, for "Soviet science never accepted these reactionary claims; it always combatted them . . . We have openly declared," he goes on to say, "and continue to declare that science, and therefore Soviet science, is a partisan science, a class science. All talk about 'the supra-class' and 'supranational' character of science is verbal nonsense."

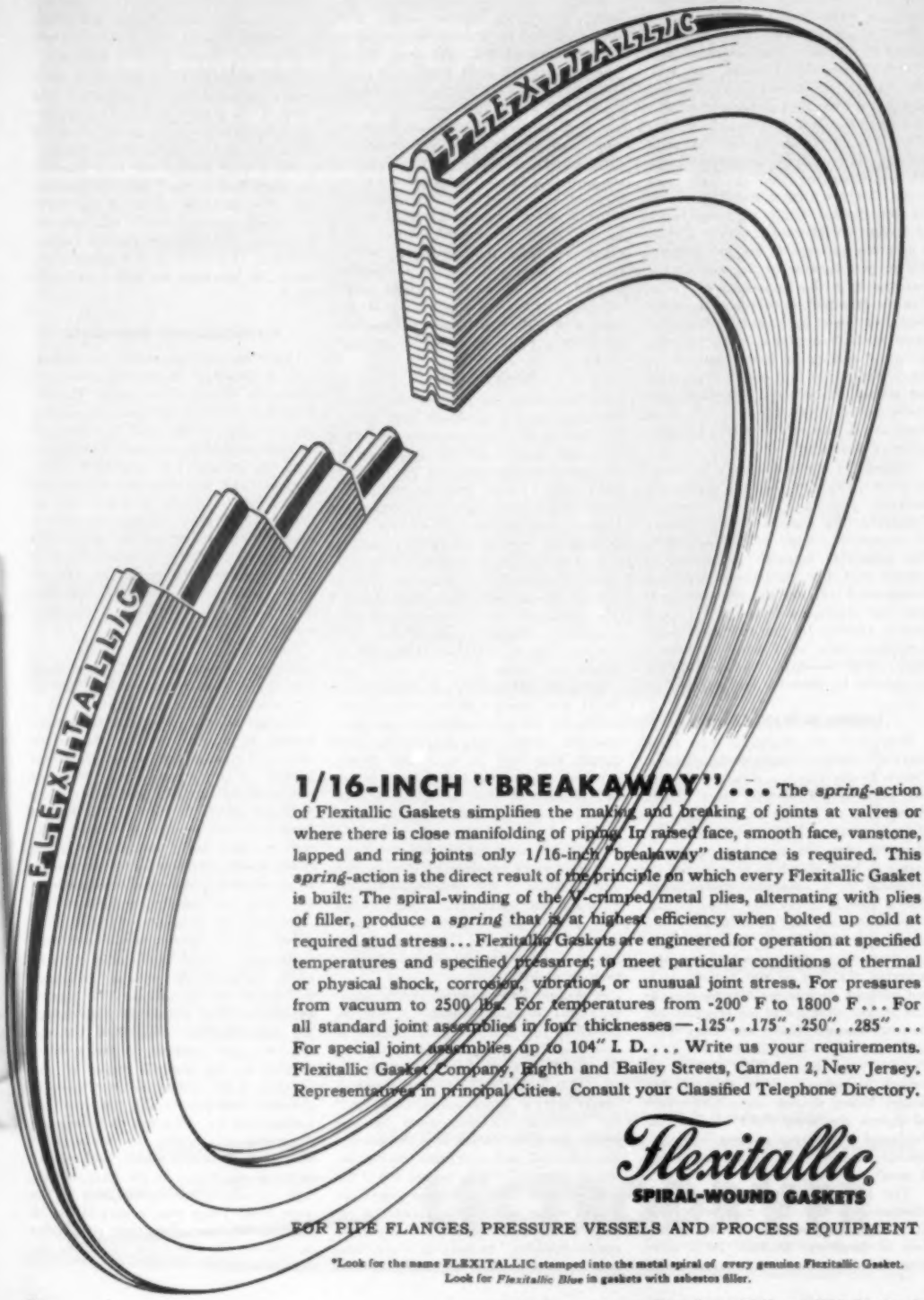
These quotations are typical of what is now being written by scientists and scholars the other side of the iron curtain. From the point of view of 40 years ago this is an amazing development; it is as though the hour hand of the clock had jumped back before our eyes. The presuppositions of the world of science are repudiated officially by the party that rules a mighty nation. Freedom of inquiry is not suppressed; rather, its premises are denied and ridiculed.

No Recognizable Descendants

Under such circumstances the equivalent of Matthew Boulton becomes of course an official of the state. The independent inventor, the amateur scientist has not only disappeared but has left no recognizable descendants. The executives operate under an alleged mandate of society, but in reality are instruments of a highly disciplined party; at all events they control and manage science. Competition—a despised bourgeois idea—is eliminated; a monolithic structure takes its place. Science and society are welded together in a totally new pattern. The break with the past has been completed.

Can such a system of science and technology be successful? For the short run, the answer must be yes. Just as you can organize, plan, and direct a concerted effort to turn the recognized corner in science, so too the whole science of a nation can be regimented for a push toward definite goals. We must not underestimate the immediate technological power of Russia. But for the long pull, the verdict of history may well be otherwise. Indeed, as a student of the history of science I believe it must be so. Once the borrowed momentum of the science of the free world has been exhausted, the progress of Soviet technology, in my opinion, will almost stop.

Barring a global war—which is by no means inevitable—the younger generation will live to see the outcome of a gigantic experiment. They will witness the result of the technological competition between the two rival solutions of the problem created by the lowered degree of empiricism in the industrial arts: the progressive solution on the one hand as exemplified by American industry and American universities, the radical solution of the fusion of society and science in the Soviet Union on the other. Where will the two systems stand, say in the year 1975? Those who expect to live to see that day may write their prophecies as you see fit. But I for one place my bet on freedom.



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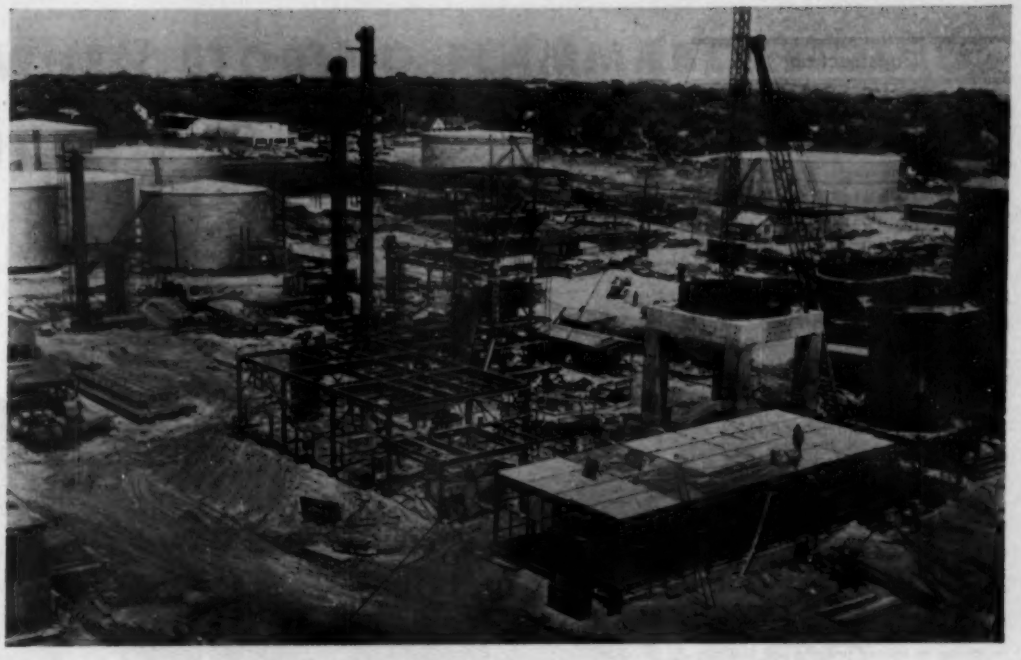


FIRST IN UNITED STATES—This Orthoflow Fluid cat cracker, the first to be built in the United States, is being erected for Cities Service Refining Company in Ponca City, Okla., by The M. W. Kellogg Company of New York. On completion, it will process 8300 barrels per day. Cracker foundation may be seen to the right behind the partly completed control house.

News Notes on Refinery and Other Plant Construction

Petroleum Refiner's Next "Box Score" Tabulation Will Appear in the October Issue

To Build 12,000 OBPD Plant Near Melbourne, Australia

Vacuum Oil Company Proprietary, Ltd., a Standard-Vacuum Oil Company affiliate, plans to construct a complete new refinery adjacent to its present small lubricating and asphalt plant at Altona near Melbourne, Australia. The project would increase the present capacity of 2000 barrels daily to slightly more than 14,000 barrels. The plans include a modern catalytic cracker, distillation and treat unit for production of motor gasoline, jet fuels, power kerosine, diesel oil and fuel oils. The plant will represent an investment of about $17 million and will operate on Middle East crudes. Production will be primarily for consumers in Australia and New Zealand.

When completed the new refinery will increase Australian refining capacity by 40 percent and, including the refinery to be constructed at Durban, South Africa, will boost the Stanvac organization's refining capacity to more than 100,000 barrels daily.

Socony Plant Expands

Socony Paint Products Company, a subsidiary of Socony-Vacuum Oil Company, Inc., has moved 90 percent of its operations from its Long Island City plant in N. Y. to Raritan Township, N. J. The move provided greater interior space as well as room for future expansion. Aside from the old Long Island City plant which it had occupied for 60 years, the company operates plants in Beaumont, Texas, and Los Angeles, Calif.

Stanolind Awards Contract For Shreveport Gas Unit

Stanolind Oil & Gas Company of Tulsa, Okla., has contracted with the Chemicals Plants Division of Blaw-Knox Company for the engineering and supply of a gasoline stripping unit to be erected at the Gilliam gasoline plant near Shreveport, La. A standard Blaw-Knox package type model, the unit will be designed to process 1.5 million cubic feet of gas per day at a pressure of 350 pounds and a temperature of 100° F. It will be equipped with a water cooling system and a safety shut-down.

Blaw-Knox Division Builds Houston Oxygen Plant

Contract for an oxygen plant to be located at Houston, has been awarded the Chemical Plants Division of Blaw-Knox Company. The equipment will be furnished by Blaw-Knox's German associates, Gesellschaft fuer Linde's Eismaschinen at Hoellriegelskreuth, Germany. The plant, a complete air separation unit, will produce 18 tons per day of liquid oxygen of 99.7 percent purity; 10,000 cubic feet per day of argon of 99.9 percent purity; and some nitrogen of high purity. Space is being provided to duplicate production capacity at a later date.

Minnesota Refinery To Operate on Alberta Crude

A $7 million refinery is under construction in Carlton County, Minn., for the newly organized International Refineries, Inc. H. H. Baskerville, president of the new refining company, is also president of Western Oil and Fuel Company. Western Oil and Fuel, a petroleum products distributor, will buy the entire refinery production. The 11,500 barrel-a-day refinery will be built

by the Lummus Company. A fluid catalytic cracking unit will be designed and licensed by Standard Oil Development Company.

Construction of the plant has been approved and certified by PAD and completion is scheduled for October, 1952. Alberta crude has been contracted from Imperial Oil, Ltd., an affiliate of the Standard Oil Company (N. J.).

Houston Chemical Plant Being Built by Phillips

Phillips Petroleum Company will erect a chemical plant adjoining its existing ammonium sulphate plant on the Houston Ship Channel. The chemical plant will produce, among other chemicals, special high purity pyridines which are used as a feed stock for other chemical fiber manufacture. Best known of the synthetic products produced from pyridines is a wool like fiber which will likely be used in the manufacture of government uniforms and supplies according to current reports. The wool industry is protesting governmental help to chemical plants engaged in such synthesis.

Phillips will build the $2.5 million dollar plant with private funds but Representative Albert Thomas of Houston is trying to secure priority for the company in the matter of materials and certification for quick tax amortization.

Ohio to Start Extensive PAD Approved Expansion

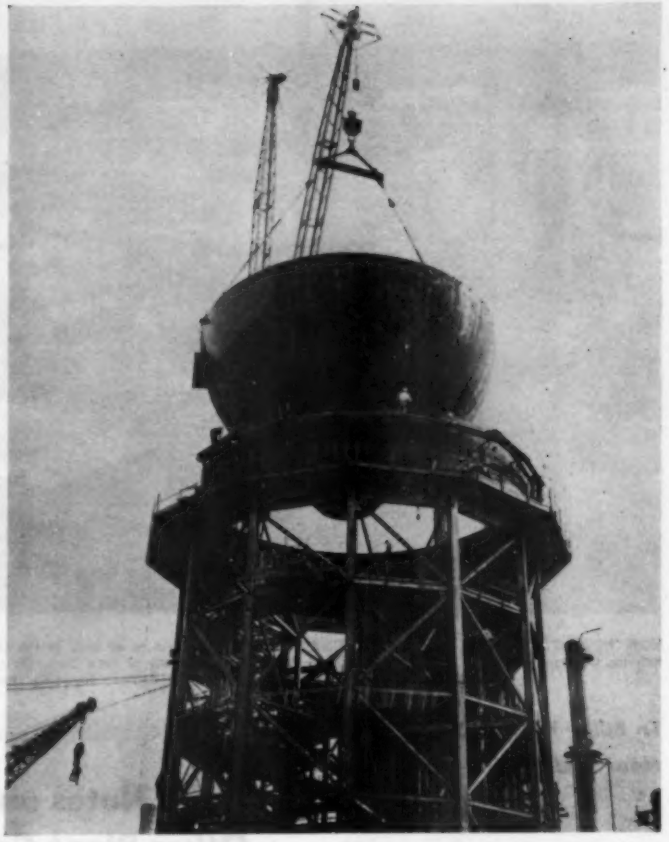
A project to increase the capacity of its Robinson, Ill., refinery by 33 percent was announced by The Ohio Oil Company. New refining units and modifications of existing facilities will boost capacity from 30,000 barrels to 40,000 barrels per day. The program which will require about 18 months, will get under way as soon as materials can be obtained.

Refining units will include a 6000 barrel coking unit and a 7000 barrel catalytic reforming unit. Additions and modifications to the crude facilities, fluid catalytic cracking unit, light ends area, power house and storage facilities are also part of the program.

In addition, refined products terminals will be constructed at Toledo, Ohio, and Mt. Vernon, Ind., to receive products by pipe line from the Robinson refinery. The new terminals will supplement similar facilities which the company operates at Indianapolis and Muncie, Ind., and Lima, Ohio. PAD has authorized certificates of necessity for the construction.

Spraberry Gasoline Plant Under Construction Soon

Phillips Petroleum Company will start construction at once on its Spraberry natural gasoline plant in Midland County, Texas, which will initially process 100 million cubic feet of gas per day. The plant site has been purchased and surveys are partially completed for pipe lines and other field facilities. The new plant will serve the Tex Harvey, Germania and Driver areas in Midland and Glasscock Counties. As field developments continue the plant will be extended proportionately to handle all additional gas discovered.



WORLD'S LARGEST THRUPUT—This regenerator bottom head being lowered into place at Gulf Oil Company's Port Arthur, Texas, refinery indicates the size of the Fluid catalytic cracker which is being built by The M. W. Kellogg Company of New York. The head alone weighs 225,000 pounds and measures 56 feet in diameter. When the unit is complete it will have the world's largest throughput—60,000 barrels per day.

DPA Approves Construction Of Plants in Gulf Coast

Eastern States Petroleum Company, Inc., was granted two certificates of necessity by DPA for construction of facilities in Houston to produce gasoline grades. DPA also approved plans of The Ohio Oil Company to build natural gas and propane producing facilities costing $4,108,414 in Matagorda County.

The Eastern States certificate also stated that 100 percent of the new facilities, estimated to cost $3.3 million, would be eligible for the government's accelerated tax amortization program. The Ohio's grant specified that 70 percent of construction cost could be written off for tax purposes.

Procon Will Install UOP Reformer Unit at Bristow

The Wilcox Oil Company of Tulsa has signed a contract with Universal Oil Products Company for the licensing of a UOP platforming reforming unit to be installed at its Bristow, Okla., refinery. Procon Corporation will begin installing the unit this fall. It is expected to be in operation by late summer 1952, and will cost approximately $1.5 million. In operation, the reformer will take naphtha and motor gasoline and step up its octane rating to 95 percent or better through the addition of tetraethyl lead.

Construction at the Bristow plant, which has a present rated capacity of 5500 barrels per day, will get under way sometime this fall.

Dow Begins $4.5 Million Research Project Program

New research facilities costing $4.5 million will be added by Dow Chemical Company to its Midland, Mich., and Freeport, Texas, plants. The Midland project will include new organic, spectroscopy and special service laboratories as well as a new technical library building.

At Freeport, the project will consist principally of an eight-building research center of 57,000 square feet. Dr. A. P. Beutel, general manager of Dow's Texas division, estimated the Freeport project would cost $2.6 million. The center will

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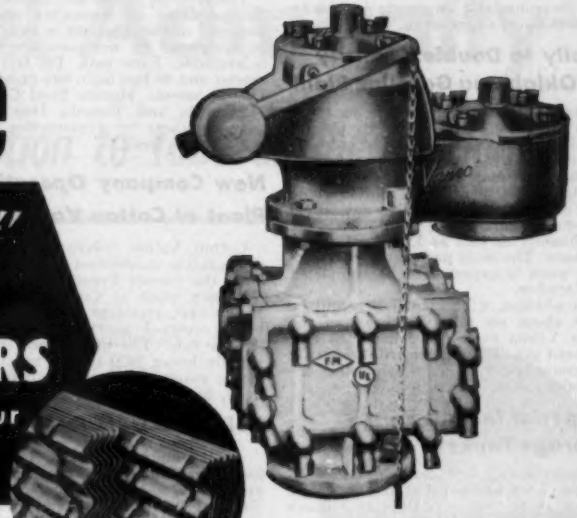

Fig. No. 5800A Conservation Vent unit consisting of "VAREC" Vent Valve in combination with VAREC Flame Arrester

The belief that conservation vents or breather valves alone will prevent travel of flame back into flammable liquid storage tanks is questionable because of the many contributing factors. Careful authoritative analysis reveals that valves by themselves do provide *some protection* but this *"protection" is by no means adequate* under all circumstances.

Safety authorities emphatically advise that "vent valves are not regarded as providing the required protection against fire and explosion." A textbook on safety states that "a conservative policy is to provide flame arresters in conjunction with other vent equipment on all cone-roof atmospheric tanks handling oils with a flash point up to 200° F. open cup."

"VAREC" Flame Arresters when used as a unit with "VAREC" Vent Valves give you full fire protection at extremely low cost. Average installations run approximately .1 of 1% of your investment in tank and products. Consult your nearest "VAREC" representative or write for further information.

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Skelly to Double Capacity Of Oklahoma Gasoline Plant

Skelly Oil Company plans to more than double the capacity of its natural gasoline plant at Velma, Okla., according to James W. Vaiden vice president in charge of manufacturing. Present capacity of the plant is 34 million cubic feet of gas daily. From this gas 50,000 gallons of butane and natural gasoline is obtained as well as 15,000 gallons of propane. The main part of the construction work is expected to be completed by October.

In addition, a booster station will be built about six miles southeast of the main Velma plant for delivery of casinghead gas. This station will eventually be converted to a natural gasoline absorption plant, Vaiden said.

Imperial Installs Ten Storage Tanks at Sarnia

Imperial Oil, Ltd., has started installation of ten additional crude oil storage tanks at its Sarnia (Alberta) refinery and upon completion of these, together with 20 other tanks now built or nearing completion, the plant's crude storage capacity will be increased to 4.5 million barrels.

The tanks will be used to store Alberta crude over the winter months when navigation on the Great Lakes is closed and tankers will be unable to move crude from the Interprovincial Pipe Line terminus at Superior, Wis. The first tanker shipments from this line commenced last April and Imperial expects to move a total of 10.7 million barrels of crude to Sarnia during the 1951 navigation season. This is the equivalent of 50 percent of the Sarnia plant's crude requirements for a full year.

The erection of the first 20 tanks will be completed in November and construction of the other ten is expected to be completed by next summer if steel is available. Each tank, 150 feet in diameter and 48 feet high, has capacity for 150,000 barrels. Horton Steel Company of Canada and Toronto Iron Works have contracts for construction of the full storage facilities.

New Company Operating Plant at Cotton Valley

Cotton Valley Solvents, Inc., is an organization established recently to operate the former Premier Oil Refining Company plant at Cotton Valley, La. Jack Coast, president of the new company, reported purchase of the plant late in July. The unit is now running slightly under 3000 barrels refining solvents, gasoline, kerosine, and diesel oil daily, he said.

Colombia Gets Refinery

At Barranca-Bermeja, Colombia, the De Mares Concession, first oil-producing area in Colombia, and operated by the Tropical Oil Company, reverted back to public control recently. The oil company had operated the concession under a long-term contract which expired Mid-August. All wells and a 25,000-barrel refinery are now property of the government; however, they will be operated under a 10-year contract by International Petroleum (Colombia) Ltd.

Sixty-Day Moratorium Is Declared On Fast Tax Write-Offs of Defense Units

Two Humble Oil & Refining Company projects were among the last construction projects processed for rapid tax amortization before a 60-day moratorium was ordered by Defense Mobilizer Charles Wilson. The moratorium became effective August 18. Refining projects reported as certified for amortization during the past month include:

Allied Chemical & Dye Corporation, North Claymont, Del., sulfuric acid unit, $3,552,000 at 80 percent.

E. I. duPont de Nemours & Company, Deepwater Point, N. J. Tetraethyl lead, 50 million pounds annually, $3,380,000. (A second project was proposed also but it is not clear whether or not DPA certified it.)

Esso Standard Oil Company, Baton Rouge, La., benzene, toluene, etc, $3,040,000.

Hancock Oil Company, Long Beach, Calif., two Thermofor cracking units of 20,000 barrels per day, a polymerization unit of 700 barrels per day, $9.5 million.

Humble Oil & Refining Company, Baytown, turbo-fuel facilities, $70,400 at 50 percent, and aviation gasoline facilities, $4,971,000.

Minnesota Mining & Manufacturing Company, Copley Township, Ohio, sulfuric acid, $2,068,850, at 80 percent.

Ohio Oil Company, Robinson, Ill., crude topping expansion of 10,000 barrels daily, catalytic cracking unit of 9000 barrels, catalytic reforming for 7000 barrels daily, and coking facilities, $7,225,033.

Phillips Petroleum Company, Sherman County, Texas, natural gasoline plant, $212,090 at 75 percent.

Socony-Vacuum Oil Company, Augusta, Kans., thermofor catalytic cracking unit of 13,500 barrels, $2,869,180.

Stauffer Chemical Company, Compton, Calif., sulfuric acid, $57,070 at 80 percent.

Through July 16 the Defense Production Administration had approved 124 oil refining facilities representing proposed investments of $587,238,000 for rapid tax amortization. The same report showed that 76.4 percent of the total refining investment had been certified for amortization, and that oil refining ranked third in investment among the 16 industries involved in production or fabrication of basic materials. Iron and steel led the list and the chemical industry ran second.

Celanese to Build New Main Laboratory Plant

Celanese Corporation of America will begin construction of a main laboratory building at Clarkwood, Texas, petroleum chemical research and development center, at a cost of approximately $500,000. Estimated to be ready for use within a year, it will provide specially designed laboratories suitable for different types of research work on the production of chemicals from petroleum raw materials, as well as facilities for the use of modern physical analytical equipment involving infrared, ultra-violet and mass spectrometric techniques.

The Bishop, Texas, plant is engaged in a building program which will add several new production units, and new chemical plants are in the initial stages of construction at Pampa, Texas, and Edmonton, Alberta.

Pecos Expansion Adds 10,000 Gallons Gasoline

A $900,000 expansion project which will add approximately 2500 hp. additional compressure in the plant, as well as a revamping of the distillation and absorption units, is underway at the Pecos Petroleum Company, 35 miles north of Pecos, Texas. Expected to be completed in February, 1952, the expansion will mean a daily gasoline production increase of about 10,000 gallons; while butane and propane production will be stepped up by 12,000 gallons per day, according to an estimate by T. C. Shaw, executive vice president and general manager.

Plans also call for 15 miles of pipeline to meet the El Paso Natural Gas Company's line in New Mexico.

Moose Jaw Plant Awarded For 4-Year Safety Record

The British American Oil Company refinery staff at Moose Jaw, Saskatchewan, will receive an additional day's pay as acknowledgment of completion of their fourth year of operation without a lost-time injury. Man-hours worked by the Moose Jaw refinery employees during the 1460 days totaled 955,107. B-A initiated an intensive safety program several years ago and employs a full-time safety supervisor in every refinery and marketing division. The Moose Jaw refinery is presently being modernized and expanded. When construction is completed next year the plant will have a daily processing capacity of 15,000 barrels of crude oil.

Montana Plant Adding 5000 BPD Cracking Unit

A 5000 barrel daily catalytic cracking unit and a 483 barrel polymerization unit, with a yield of 180 barrels of LPG, are under construction for the Farmers Union Central Exchange Inc., of Laurel, Mont. Refinery Engineering Company is erecting the two $3.5 million units which were licensed and designed by Universal Oil Products Company. The project is scheduled for completion sometime in November, 1952.

Indiana Standard Program

A $190 million expansion program is underway for Standard Oil Company (Indiana) to help that company meet increasing demands for petroleum prod-

ANACONDA Arsenical Admiralty—

a practical solution to tube dezincification

What causes dezincification?

Metallurgical research indicates a number of conditions causing dezincification of condenser and heat exchanger tubes:

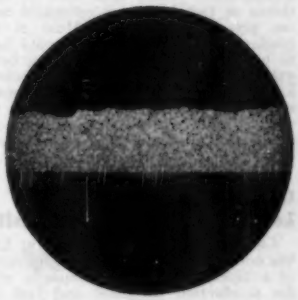
LAYER TYPE dezincification tends to be the result of a critical degree of acidity of the cooling water.

PLUG TYPE dezincification is more apt to occur where the cooling water is neutral or alkaline.

LOW WATER VELOCITY may accelerate the loss of zinc by failing to wash away copper salt solutions, thereby permitting redeposition of copper.

HIGH COOLING WATER TEMPERATURES hasten over-all corrosion reactions and seem to favor the electrochemical process causing redeposition of copper.

LOW OXYGEN CONTENT of cooling water is also considered a factor in accelerating the redeposition of copper. M1177



Longitudinal section through Arsenical Admiralty tube. No evidence of dezincification. Upper surface is waterside. 7x.

Longitudinal section through wall of non-Arsenical Admiralty tube showing dezincification plug starting from waterside (upper surface). 7x.

Arsenic as an Inhibitor

Laboratory studies and field installations have clearly indicated the effectiveness of small quantities of arsenic in Admiralty and other copper alloys as an inhibitor to dezincification. The inhibiting action of arsenic, as well as of other inhibitors, is not well understood. One theory holds that the inhibitor covers anodic areas to prevent initial selective corrosion; another states that it forms a film of an electropotential equal to that of the copper to prevent the copper redepositing.

For Technical Counsel

The files of Anaconda's Technical Department and the experience of its engineers cover the case histories of condenser and heat exchanger tubes operating under the widest variety of conditions. These are freely available to you to help you select the right alloy for your installation. The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

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ucts, according to Dr. Robert E. Wilson, board chairman and A. W. Peake, president, who reported that consolidated net earnings of Indiana Standard and its subsidiaries increased 35.4 percent over the first half of 1950.

India Asks Oil Companies To Construct Refineries

India is reported to have requested three foreign oil companies to set up refineries in India under a 30-year guarantee of no nationalization. The companies who were approached were Caltex and Standard Vacuum and Burmah-Shell. The Indian proposal would give the oil companies full control over capital and management and promises compensation if nationalization is carried out after the 30-year period.

The government suggestion is that a 40,000-barrel-daily refinery would be set up in the state of Bombay, or that two 20,000-barrel refineries be set up, one in Bombay and the other in Madras. Either arrangement would take care of two-thirds of India's annual estimated need for petroleum products. Most of the crude oil for the refineries would have to be imported as all the oil now being extracted locally already is being refined in Assam. Procurement of crude, preferably from sterling areas, would be the responsibility of the oil company or companies accepting the offer to build such a refinery.

Caltex Gets Nod from Lebanon for Refinery Unit

California-Texas Oil Company, Ltd., has completed plans for the construction of a 13,000 barrels-a-day capacity plant for production of diesel and fuel oils near Sidon, Lebanon, close by the western terminus of the Trans-Arabian Pipe Line. Scheduled for completion within the next 24 months, the plant will be constructed and operated under an agreement with the Lebanon government and production will be for local consumption and Caltex bunker requirements only. Total estimated cost is $5.8 million for land and for construction.

Independent Firm Sought To Build in Israel

Private capital is sought by the Israeli Government to set up a $2.5 million polymerization and alkylation plant for the production of detergents. Such a plant would be the country's first venture into petrochemical industry. Raw materials for the proposed plant would be supplied by Haifa refineries in the form of propylene; government surveys envisage an annual output of 3000 to 3500 tons of detergents, two-thirds of which would be required to meet domestic needs.

Fawley Unit on Stream

Originally scheduled to begin operating in 1952, a 60,000-barrel-per-day crude topping still, the first unit of the new Fawley, England, refinery of Standard Oil Company (New Jersey) has gone on stream. When completed, the plant will have a daily capacity of 115,000 barrels.

Sun Construction Projects For Two Years Programmed

Sun Oil Company has embarked on a two-year construction project, costing about $40 million, to boost its refinery capacity by between 35,000 and 40,000 barrels daily. In addition, the company during 1951 will spend $4.5 million for natural gas-natural gasoline plants, and $20 million for producing facilities, $6.8 million for transportation facilities and $4 million for other installations.

The largest single item in the two-year refinery program, one-third of which is scheduled for 1951, is the construction at a cost of $10 million of a 10,000 to 15,000 barrels per day refinery at Sarnia, Ontario. This will include a Houdriflow catalytic cracker.

Under design for Sun's Marcus Hook, Pa., refinery is the new Sun-developed Arosorb process for aromatics purification. This installation will produce more than 13 million gallons of benzene, 30 million gallons of toluene and 15 million gallons of aromatic aviation gasoline blending stock annually. Also under construction to provide feed stock to the Arosorb unit is a Houdriformer unit, for catalytic reforming of low octane petroleum naphthas. This unit will have a charging capacity of 13,000 barrels daily of naptha. A lubricating oil plant, which is a combination crude and vacuum distillation unit for production of 250,000 barrels monthly of napthenic-type lubes, and a propylene polymerization plant with a charging capacity of 6000 barrels, to produce high quality gasoline from propylene recovered from refinery gases, is also under construction at Marcus Hook.

The company also has under construction at Marcus Hook a large ammonia (refrigeration) unit to be operated as part of the alkylation plant to maintain constant high quality production of aviation alkylate throughout the year. Previously, the charging rate at the alkylation plant had to be reduced during summer months because of high cooling water temperatures. On the basis of this new plant alone Sun has been able to offer the Armed Forces an additional 1,000 barrels a day of aviation gasoline.

Other scheduled Marcus Hook projects are a plant for producing sulfonates and napthenic acids; extension of docks to accommodate the two new super-type tankers of 30,000 deadweight tons under order by Sun; construction of additional storage tanks; and additions and improvements to existing lubricating oil, catalytic cracking and tetraethyl lead blending units to increase efficiency and output.

At the Toledo refinery the principal project planned is a 10,000 barrel catalytic naphtha reformer which incorporates a UOP Platforming process. Another Toledo project is construction of a 4000 barrel propylene polymerization plant similar to the type under construction at Marcus Hook.

Luby Gasoline Plant Enlargement Completed

An expansion program begun in March of this year has been completed at the Luby, Texas, gasoline plant, co-owned by Stanolind Oil and Gas Company and Seaboard Oil Company of Delaware.

New equipment includes a low-pressure gathering system; additional compressors (total horsepower now 6640); a new 1000-psi absorber; a steam condenser; a direct-fired oil heater, additional storage facilities, etc.

V. E. O'Donnell is plant superintendent.

The casinghead gas, which enters the plant at a very low pressure or slight vacuum and is compressed to 1000 psi, then passes through the high-pressure absorber where natural gasoline and butane are removed by an absorption oil. The gasoline, butane and absorption oil are then separated in the fractionation towers. The natural gasoline and butane flow into storage tanks and the residue or dry gas is further compressed to 2000 psi for injection into the oil producing formation in the Luby field.

The plant's increased pressure and capacity will double the recovery of butane-propane mix, O'Donnell said. Operating at its peak capacity of 27 million cubic feet of gas daily, the plant will recover 31,000 gallons of natural gasoline and 21,000 gallons of butane-propane mix.

This latest construction at Luby is the fourth enlargement or addition that has been made since the original plant was built in 1939. Stanolind engineers designed the enlargement and construction was carried out by the Gasoline Plant Construction Company, Houston.

Construction to Start on Sulfur Removal Plant

Royalite Oil Company, Ltd., will begin construction of a $350,000 sulfur plant next month in the Turner Valley of Alberta. Foster Wheeler Ltd., of Toronto will build the plant which is designed to process 30 tons of sulfur daily. The new unit will adjoin Royalite's scrubbing and hydrogen removal plants and is scheduled for completion in April, 1952. The plant will be used to recover elemental sulfur from the hydrogen sulphide from Turner Valley's natural gas.

Sun and Ohio to Build Texas Gasoline Plant

A joint venture between Sun Oil Company and The Ohio Oil Company will result in a gas processing plant in Matagorda County, Texas. The plant will be capable of processing 91 million cubic feet of gas daily, with a yield of approximately 17,500 gallons of propane, 17,300 gallons of butane, and 1960 barrels of stable condensate. The project is under construction now and the Hudson Engineering Company is the contractor. Unitization of the plant is contemplated according to Ohio Oil officials.

Delta Building Refinery Project Near Memphis

Delta Refining Company, a subsidiary of MFA Oil Company, is building a $1.7 million gasoline plant, incorporating catalytic cracking and auxiliary facilities, near Memphis, Tenn. A crude oil topping unit will process 2000 barrels daily, while the catalytic cracker will be processing 2200 barrels daily when the project is completed in 1952. In addition a catalytic polymerization unit will have a capacity of 100 barrels daily. These units will increase the refinery capacity from 4000 to 6000 barrels per day.

More Plant Construction News Items Page 313

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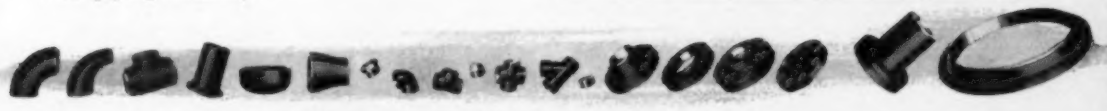

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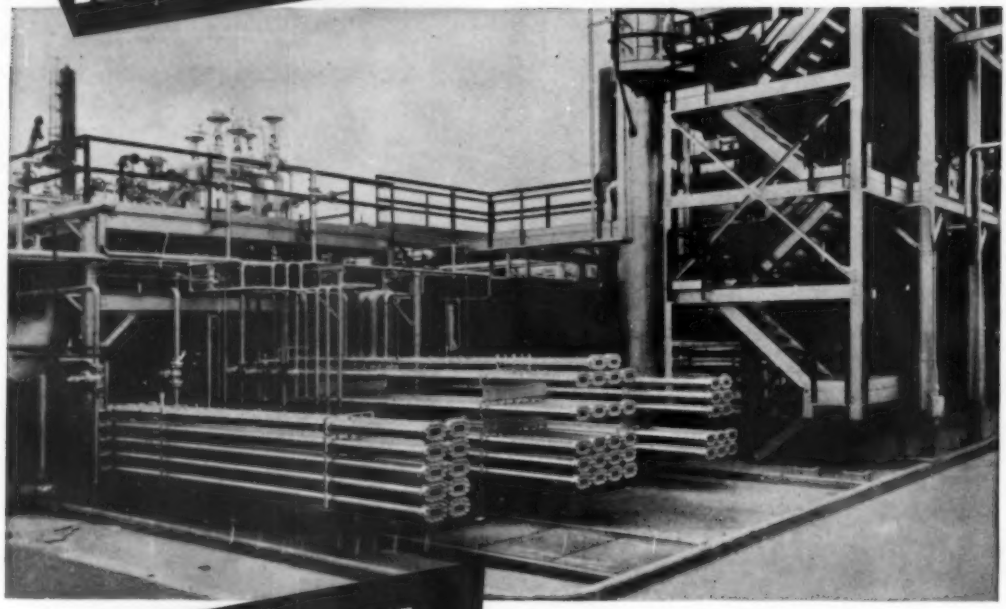

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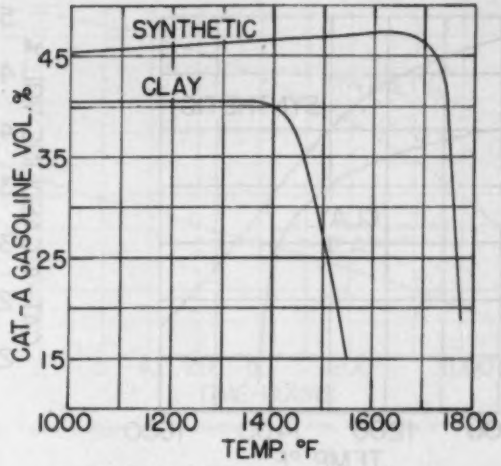


Figure 1. Thermal Deactivation by 10 Hours in Dry Air.

Factors Controlling Aging of Cracking Catalysts

PETROLEUM REFINER
SEPTEMBER, 1951

G. A. MILLS and H. A. SHABAKER
Houdry Process Corporation, Marcus Hook, Pa.

PETROLEUM refiners engaged in catalytic cracking are faced with the problem of maintaining efficient catalyst performance. However, cracking catalysts in commercial use lose not only activity but sometimes also the ability to produce a desirable distribution of products. Therefore, the maintenance of catalyst efficiency in the refinery is more important than initial catalyst efficiency. This report on the matter was presented to the Western Petroleum Refiners Association at the February, 1951, regional meeting at Lake Charles, La.

In order to determine how to prevent or at least minimize catalyst aging, it is necessary to understand the factors controlling catalyst aging. Although the results of aging cracking catalysts have been readily apparent, the causes have been recognized only slowly. The fact is that the aging process does not occur in a simple way from a single cause. During the cracking process, catalysts are subjected to hydrocarbons at about 800° to 950° F. and to products of combustion at temperatures as high as 1150° F., perhaps considerably above on the catalyst surface. In addition there may be present steam and other compounds, such as those containing nitrogen and sulfur, as well as entrained contaminants. These are the conditions causing alterations in catalysts which ultimately are observed as deactivation. Frequently, catalyst deactivation in commercial operation is a combination of the various causes.

FACTORS which have been found important in catalyst aging are: the chemical nature of the gases to which the catalyst is exposed, the time and temperature of this exposure, the type of catalyst, and contamination of the catalyst by metals entrained in the charge stock.

Temporary Inactivation

During the on-stream cracking period there is a progressive loss of activity which is due to coke deposited throughout the catalyst. This is temporary in the sense that activity is restored by simply burning off the deposit with air. However, a more potent cause of temporary catalyst inactivation may occur. Basic nitrogen compounds contained in certain feed stocks, attach themselves to the catalyst, neutralizing the active acid centers of the catalyst.[1] Small amounts of such nitrogen compounds are sufficient to cause considerable loss in activity as illustrated in Table 1.

These data show, a) how gasoline yield can be lowered by adding a basic nitrogen compound whose homologs are found in petroleum and, b) how gasoline yield can be improved by acid extraction of a nitrogen containing feed stock. Normal regeneration restores catalyst activity. The coke may be relatively high if much of the nitrogen compounds is present. In practice, when processing high nitrogen feed stocks, it has not proven economical to extract using an acid such as formic. Instead, a recycle operation may be employed, the acid catalyst removes nitrogen compounds on the first pass and a recycle stock is obtained of very favorable cracking properties.

Permanent Inactivation

In normal operation catalyst aging occurs because of the high temperatures to which the catalyst is exposed.

TABLE 1

Temporary Poisoning by Nitrogen Compounds

PETROLEUM STOCK TESTED	Catalyst Test: 850 °F., 20 Percent Steam, Houdry S-35 Catalyst				
	Percent N	Gaso. Vol. Percent	Coke Wt. Percent	Gas Wt. Percent	Gas Gravity Air = 1.0
40–89 Percent East Texas Crude	0.04	38.2	3.3	10.0	1.66
60–89 Percent + Quinoline	0.24	23.0	3.5	6.1	1.47
Los Angeles Basin Gasoil	0.23	32.0	3.6	8.1	1.50
Los Angeles extracted with formic acid with 3 percent vol. removed of gas oil[2]	0.13	38.3	2.9	10.7	1.66

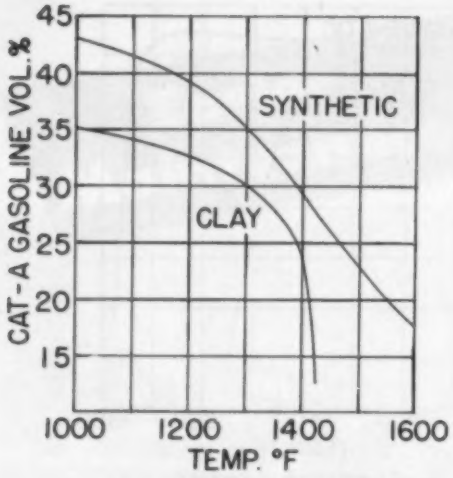


Figure 2. Steam-Thermal Deactivation by 4 Hours in 1 Atm. Abs. Steam.

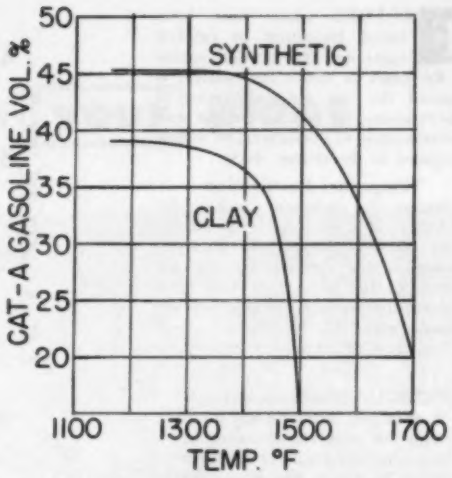


Figure 3. Partial Steam-Thermal Deactivation by 10 Hours in 0.1 Atm. Abs. Steam.

Steam greatly accelerates the rate of aging over that occurring in inert gases—air, CO_2, CO, etc. It is not possible to avoid this aging completely but an understanding of the relationship between loss of activity and temperature can lead to minimizing the loss.

In Figure 1, taken from an article by H. A. Shabaker,[3] is plotted the activity of Houdry synthetic silica-alumina catalyst and of Filtrol TCC clay catalyst as a function of temperature treatment in dry air. The activity is measured by the gasoline yield in a standard laboratory catalytic acticity Test A.[4] This test will be discussed later. In Figures 2 and 3 are shown the activity-temperature relationships in the presence of 1 atmosphere and 0.1 atmosphere steam. These high temperatures constitute an accelerated aging test. A comparison of the curves brings out the strong inactivating effect of steam which is increased with higher steam pressure.

In Figure 4 are shown the time-activity relationships of the standard catalysts when aged in steam at 950° F.

Upon detection of loss of catalyst activity in the plant, it is important to assign a cause. This can be greatly aided in the case of normal aging by simply measuring catalyst density. In Figures 5 and 6 are shown the density vs. activity comparisons corresponding to catalysts treated in air or in steam. It is most significant that density changes only slightly for low temperature steam deactivation but greatly for air deactivation which occurs only at very high temperatures. The densities refer to a bulk density obtained by weighing a packed volume of catalyst. Loss of activity is also paralleled by loss of surface area.[5] Catalysts of the same type receiving the same type of treatment must be compared.

Catalyst Activity and Selectivity

The cracking properties of a catalyst are usually evaluated by passing oil over the catalyst under standard test conditions and collecting and measuring the reaction products. These products are conventionally separated according to boiling point into fractions classified as gas, gasoline, gas oil, and catalyst deposit or coke. The activity of a catalyst may be measured broadly by the over-all conversion of charge stock into products boiling in a range other than that of the charge stock. Catalyst selectivity is determined by the distribution of products and here refers to the production of gasoline relative to coke and gas.

The activity and selectivity of crack-

TABLE 2

Catalyst Aging with Loss of Selectivity

(New catalysts were adjusted to the activity shown by calcination in a steam atmosphere)

CATALYST	CATALYTIC ACTIVITY TEST A					
	Gasoline Vo. Percent	Coke Wt. Percent	Gas Wt. Percent	Gas Gravity (Air = 1.0)	Coke Factor	Gas Factor
I TCC Filtrol Clay (equilibrium catalyst commercial unit[a]):						
A	29.3	1.9	3.5	1.44	1.12	1.09
B	29.3	2.2	4.8	1.10	1.22	1.37
II[b] TCC Filtrol Clay:						
New	32.9	2.4	3.3	1.40	1.30	0.87
After 135 cycles Gach Saran vacuum distillate	23.6	3.5	5.1	0.67	2.26	1.75
Houdry Synthetic:						
New	38.5	2.2	6.7	1.54	0.96	1.08
After 116 cycles Gach Saran vacuum distillate	26.7	2.7	8.5	1.43	1.12	1.33
After 116 cycles Gach Saran tar separator overhead	34.9	2.5	7.9	1.23	1.19	1.36
III[b] TCC Filtrol Clay:						
New	30.3	4.3	7.4	1.48	1.23[c]	1.10
After 90 cycles Hawkins	33.0	3.7	6.3	1.10	1.45	1.31
Socony-Vacuum: Silica-alumina beads:						
New	37.7	2.0	5.5	1.54	0.96	0.97
After 110 cycles Hawkins	35.2	2.4	6.4	1.45	1.30	1.19

CRACKING CONDITIONS

II = 850° F., 1.0 LHSV atmospheric pressure, 20 minutes on stream, 10 percent steam, Gach Saran vacuum distillate 55-76 volume percent of crude (1.8 percent S), tar separator overhead 53-81 volume percent of crude (1.8 percent S).

III = 875° F., 1.0 LHSV, 10 psig., 20 minutes on stream, 5 percent steam, 48 volume percent overhead from Hawkins reduced crude (1.46 percent S).

[a] Samples were withdrawn from the same commercial unit: Sample A after normal operation, Sample B after feed distillation conditions altered permitting entrainment.

[b] Examples II and III were run in a fixed-bed pilot plant under simulated TCC conditions, 5 cycles being equivalent to 1 operating day in a plant. Samples of catalysts in examples II and III were representative of the top half of the catalyst bed; samples from the bottom half showed less severe aging.

[c] New air calcined catalysts may show temporary high coke and gas factors due to insufficient stabilization by this mild calcination.

ing catalysts are evaluated in this laboratory by the catalytic activity Test A.[4] Light East Texas gasoil is passed over a 200-ml. fixed bed of catalyst at 800° F. for a 10-minute period at 1.5 liquid hourly space velocity. The products—gas, gasoline, gasoil, and coke—are measured under well defined conditions. The coke figure actually refers to the amount of carbon in the catalyst deposit.

The distribution of products obtained with two catalyst types using this standard cracking test is shown in Figure 7. These catalysts were adjusted to different activities by treatment with steam at temperatures above 1000° F.

In order to determine catalyst selectivity from the products distribution of a cracking test, it is not sufficient merely to consider gasoline-to-coke and gasoline-to-gas ratios. These ratios are not constant for a given catalyst but depend on conversion level obtained in the cracking test. This is evident from Figure 7. This plot is the basis for determining the selectivity of any catalyst sample by comparison of the products distribution obtained with the sample under the standard cracking test conditions. Of course, cases of severe loss of selectivity are obvious since gasoline yield may be decreased with actual increases of coke and gas.

The selectivity of a cracking catalyst may also be expressed numerically as a carbon-producing factor and a gas-producing factor.[6] These are the ratios of carbon and gas yields obtained with the catalyst tested to the carbon and gas yields, respectively, obtained with a standard catalyst at the same conversion of gasoil. These factors appear in the data and the discussion which follows. The errors in the catalytic activity Test A, already mentioned, are such that the coke and gas factors ordinarily can be interpreted as showing loss of selectivity only when they are greater than 1.15 or even 1.20.

Data illustrative of catalysts showing loss of selectivity are shown in Table 2. The catalysts were all evaluated by the standard catalytic activity Test A, so that the results could be compared directly. The values listed in Table 2 refer to the results of this test made before and after the aging conditions stated. It is evident that loss of selectivity may be mild or very severe. A decrease in gas gravity offers a very sensitive indication and is apparent before any change of other products is observed.

Influence of Metal Impurities on Selectivity

Before discussing Table 2 in more detail, the effect of heavy metals in the catalyst in active form will be considered. A number of catalysts were prepared containing added amounts of vanadium, copper, iron or nickel oxide. The harmful effects of vanadium, copper or iron are shown in Figures 8, 9, and 10. These curves are taken from paper dealing with loss of selectivity in aging of cracking catalysts.[7]

Nickel, like copper, was found to be approximately ten times as effective as iron in causing loss of selectivity. The quantitative relation between the amount of metal and its effect is dependent on the distribution of the metal over the catalyst surface and its condition there. In some instances, plant-aged samples have been observed to contain relatively high amounts of iron oxide or rouge, evidently from plant equipment, concentrated on pellet exterior with but little loss in catalyst activity or selectivity. The catalysts referred to in Figures 8, 9 and 10 were prepared by impregnation with ammonium metavanadate, copper nitrate, or ferric nitrate, followed by thermal decomposition. Physical admixture of catalyst and ferric oxide powders resulted in a product which also showed marked loss of selectivity. In this case a different relation between loss of selectivity and amount of iron was found than that expressed in Figure 10.

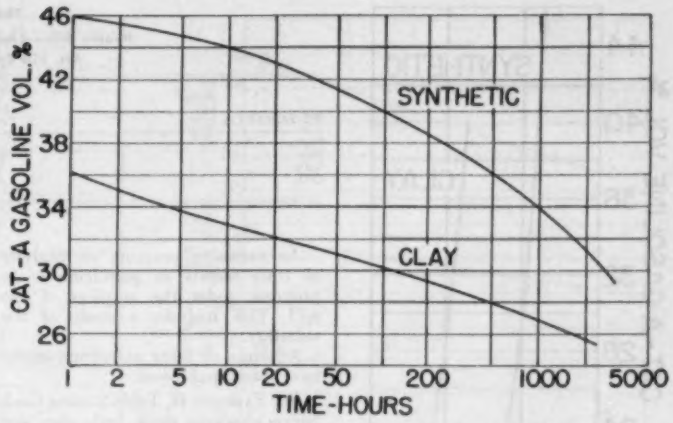


Figure 4. Steam-time Deactivation by 1.0 Atm. Abs. Steam at 950° F.

Effect of Gases on Catalyst at High Temperature

To determine the consequences of different conditions to which catalysts may be subjected, the effects of gases on catalysts at high temperatures were studied. It was found that the effect on the activity and selectivity of catalysts depends critically on the chemical nature of the gases and on temperature. The two commercial catalyst types, clay and synthetic silica alumina, behave quite differently in the presence of certain gases.

It appears that synthetic silica alumina does not suffer a marked loss of selectivity. On the other hand, clay is abnormally aged by some gases, particularly hydrogen sulfide.

The gases fall into the following classifications:

1) Inert: air, CO_2; SO_2 and NH_3 below about 1150° F.
2) Hastens normal aging: steam.
3) Causes abnormal aging of clay but not synthetic catalyst: H_2S above 800° F.; NH_3 and SO_2 above about 1150° F.

The effect of hydrogen sulfide is shown in Table 3.

The abnormal aging suffered by clays, but not by synthetic catalysts, focuses attention on the differences in their chemical composition. This comparison brings out the difference in iron content. From what has been said previously and considering the favorable cracking properties of Filtrol TCC clay, the large amount of iron present in clay catalyst must be inactive. Although the iron in the clay is originally inactive, it is brought into

TABLE 3
Effect of Hydrogen Sulfide Concentration

Percent H_2S in Atmosphere during Calcination of New Filtrol TCC for 5 Hours at 1000 °F.	Gasoline, Vol. Percent	Coke Wt. Percent	Gas Wt. Percent	Gas Grav. (Air = 1.0)	Coke Factor	Gas Factor
0	38.5	3.6	6.5	1.51	1.11	1.07
20	34.8	6.3	9.3	0.66	2.70	2.17

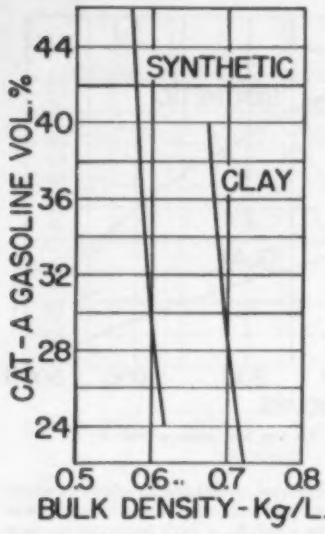


Figure 5. Bulk Density Vs Activity by 950° F. at 1.0 Atm. Abs. Steam.

catalytically active form by sulfur compounds.

Metal Contamination of Catalyst by Entrainment in Charge Stock

The transfer of metals from oil to catalyst obviously deteriorated both synthetic and clay catalyst. In Example I, Table 2, Sample B shows a definite loss of selectivity, though relatively slight. This is also evident from the increase in the coke and of the gas factor to 1.22 and 1.37, respectively. Nickel was identified as the constituent causing abnormal aging, the NiO content being 0.009 percent and 0.036 percent in the catalyst for sample A and B, respectively. The increased nickel content in the oil was due to removal of internals in a tar separator with what is believed mechanical entrainment of nickel. The nickel content of the plant tar separator stock was measured and is high compared to a laboratory distillation, Table 4, California gasoil.

TABLE 5

Houdry Silica-Alumina Pellet Catalyst
Aft. 116 Cycles O. Saran

WT. PERCENT	Fresh Catalyst	Top 25 ml.	Top Half	Bottom Half	Av. Gain (Corrected for Blanks)
Fe_2O_3	....	0.09	0.09	0.07	....
NiO	0.001	0.10	0.012	0.008	0.013
V_2O_5	0.008	0.55	0.06	<0.006	0.049
CuO	0.001	0.05	0.031	0.034	....

An extensive program on analysis of trace metals in petroleum is in progress under the auspices of the API. This includes a study of the volatility.

Analyses of other petroleum stocks have been published.[7]

For Example II, Table 2 using Gach Saran charging stock both clay and synthetic are aged abnormally, the clay much more so than the synthetic. The results given in Table 2 for cracking light East Texas gasoil in the standard test show the same loss in selectivity as the actual stocks with which aging occurred. For Example II when cracking Gach Saran vacuum distillate over clay catalyst, the yields based on the charge were, at the start and at the end of the aging runs, respectively: gasoline 35.3, 27.0 volume percent; coke 5.1, 6.5 weight percent; gas 8.5, 8.5 weight percent; and gas gravity 1.06, 0.73 (air = 1.0). For synthetic using the same charge stock corresponding data are: gasoline 39.6, 36.2 volume percent; coke 5.0, 6.9 weight percent; gas 10.2, 13.0 weight percent; and gas gravity 1.36, 1.11 (air = 1.0).

The accumulation of metal on a catalyst may be correlated with the metal content in the oil ash. Also shown in Table 4 is the ash composition of Gach Saran. It is evident that the Gach Saran ash contains relatively large amounts of nickel and vanadium, especially the latter. It is difficult to deduce any reliable conclusion from the iron figures since iron may be the result of contamination during handling of the oil. The result of relatively short aging studies with these two stocks in a 600-ml. case has shown loss of selectivity only in the case of the Gach Saran (Table 2, Example II). Chemical analysis of the catalyst aged with Gach Saran tar separator overhead shows the deposition of nickel and vanadium. (Table 5.)

Comparison of these amounts of heavy metal with the data of Figures 8, 9 and 10 clearly demonstrates that the metals can be added in sufficient quantity to poison a catalyst severely. The metals are believed to be added by entrainment of their salts. Metals may also occur in the form of completely vaporized compounds. Recent work has shown copper to be volatile. This may explain why copper was not found in the oil but has appeared rather consistently in the catalyst. It may be that the method of analysis of the oil involving a certain amount of evaporation is not adequate for copper. Comparison of the metal contents of oil and catalyst gives fair agreement between amounts charged and recovered, especially where one considers the accuracies involved in working with the small amounts and the distribution of the metals shown.

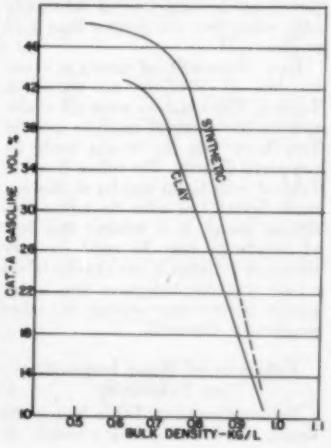
The contamination of catalysts by metals carried by the charge stock provides an explanation for loss of selectivity only in certain cases. In

TABLE 4

Comparison of Heavy Metal Content of Various Charging Stocks

STOCK	40-58 Percent East Texas	53-81 Percent Gach Saran	55-76.3 Percent Gach Saran	California Gas Oil	California Gas Oil
PREPARATION	Tar Separator	Tar Separator	Vacuum Distilled	Plant Tar Separator	Laboratory Fractionation
METALS pp.m.:					
Fe	1.86	1.22	....	4.35	4.24
Ni	<0.02	1.04	....	3.87	0.39
V	<0.02	5.50	....	....	....
Cu	<0.07	0.28	....	0.47	0.48
Total Ash Percent of Oil	0.00061	0.0014	0.0006	0.00161	0.00138
Sulfur Percent of Oil	0.3	1.85	1.82	....	....

Figure 6. Bulk Density Vs Activity by Thermal Deactivation in Dry Air.



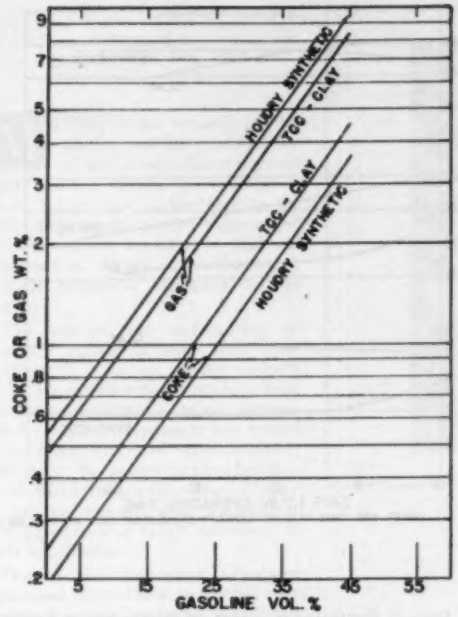


Figure 7. Catalyst Selectivity—Catalytic Activity Test-A.

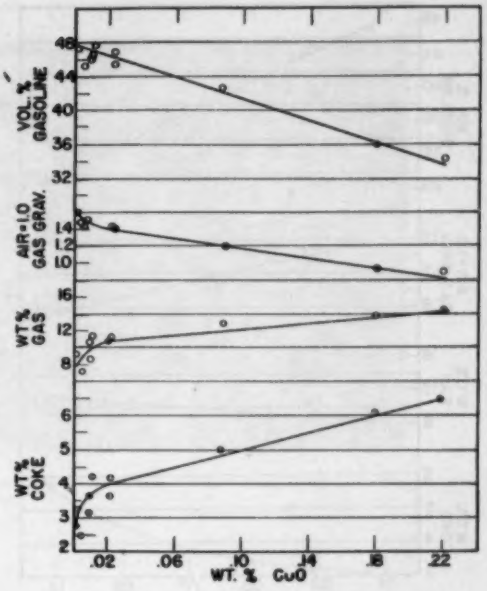


Figure 9. Effect of Copper on Selectivity of Houdry Synthetic Silica-Alumina. Catalytic Activity Test-A.

commercial refining practice it has been observed that loss of selectivity is more frequent and often more severe with clay than with synthetic catalysts. It has been widely recognized that high sulfur stocks are associated with abnormal aging of clays. Much confusion has existed because of the occurrence of heavy metals in certain sulfur-containing stocks but not in others. In a few cases unequivocal evidence has been obtained with sulfur charge stocks where abnormal aging was clearly obtained with clay catalyst but not with synthetic. These stocks contain little heavy metals, the presence of which would poison both natural and synthetic alike. Table 2 shows a case of abnormal aging of clay but not of a synthetic when charging a Hawkins vacuum distillate. Aging curves are shown in Figure 2. The analysis of the top 25 ml. of catalyst is given below and shows, with the possible exception of copper, a heavy metal increase of low magnitude. This is in sharp contrast to the results with Gach Saran (Table 6.)

Figure 8. Effect of Vanadium on Selectivity of Houdry Type—1 Catalyst. Catalytic Activity Test-A.

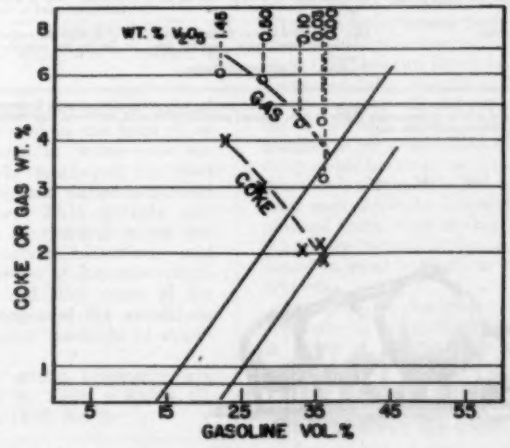


TABLE 6

WT. PERCENT	CuO	NiO	V_2O_5
Houdry Type I, new	0.005	0.005	0.008
Top 25 ml., after aging study on Hawkins	0.035	0.01	0.008

The reaction of iron with sulfur compounds is partially prevented by the presence of water vapor. The prehydration technique[9,10] lessens abnormal aging of clay catalyst. This is an important commercial procedure. It has been described in some detail in the references cited.

The total sulfur content of an oil is not an accurate guide to its harmful effect on clay, however, because not all organic sulfur compounds are equally able to activate the iron. For example, sulfides cause rapid aging of clay but not synthetic, whereas thiophene and its homologs have little effect on either catalyst.

A catalyst showing low gasoline and high coke and gas can be at least partially restored by steam treating;[9] heat treatment in dry air at temperatures up to 1400° F. has been found to act similarly. It is believed that the abnormally aged catalyst contains active heavy metals and retains the active silica alumina catalyst centers. On

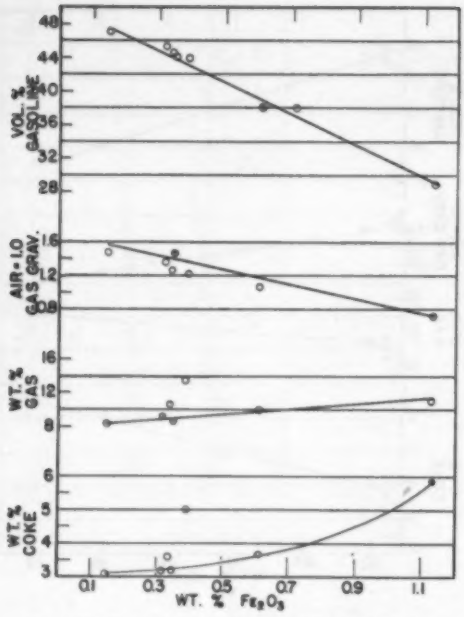


Figure 10. Effect of Iron on Selectivity of Houdry Synthetic Silica-Alumina. Catalytic Activity Test-A.

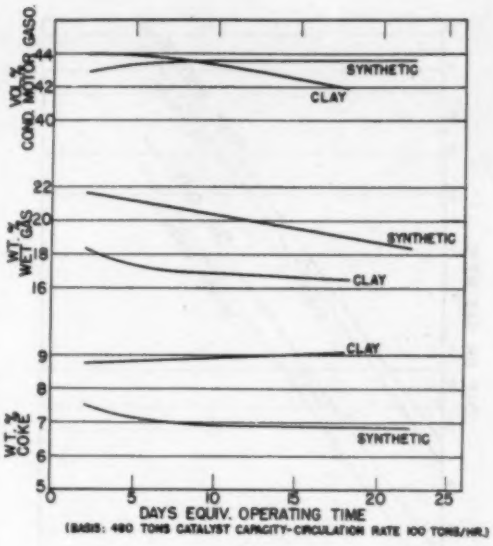


Figure 11. Deactivation of Catalyst with Hawkins Vacuum Distillate (1.46 Percent S); Fixed Bed Pilot Plant Simulated TCC Cycle. On Stream Conditions 875° F., 10 Psig., 1.0 LHSV, 20 Minutes, 5 Percent Steam. Yields Percent of Charge.

heat treatment it is possible to inactivate the iron at a faster rate than the silica alumina.

Finally, the factors controlling aging of cracking catalysts have been summarized in tabular form (Table 7.)

TABLE 7

Aging of Cracking Catalysts

CAUSE	EFFECT*	PREVENTION OR MINIMIZE
Temporary:		
Hydrocarbons form coke.	Normal activity decline.	Low partial pressure of hydrocarbon.
Basic nitrogen compounds neutralize active acid catalyst.	Gasoline yield low, coke relatively high, gas gravity normal	Recycle crack. Remove N compounds from stock.
Permanent:		
Steam above about 900 °F.	Normal activity decline.	Operate with as low a temp., time and partial pressure of steam as possible
High temperatures, >1400 °F. for TCC-clay or >1700 °F. for synthetic.	Normal activity decline. Pellet density increases.	Avoid overheating during regeneration.
Charge stock contains heavy metals.	Abnormal activity decline. Gas has low gravity.	Free charge stock of heavy metals; prevent entrainment in distillation.
High sulfur stocks.	Clay—Abnormal activity decline by activation of iron in clay. Gas has low gravity. Synthetic—Normal activity decline.	(a) With TCC-clay employ prehydration (b) Use low iron catalyst.

* Normal activity decline refers to decrease in ability to form gasoline with corresponding decrease in gas and coke, Figure 7, while abnormal activity decline means ability to form standard products distribution has altered unfavorably with gas and coke producing factors greater than unity.

REFERENCES

[1] Mills, Boedeker and Oblad, J. Amer. Chem. Soc. **72**, 1554 (1950).
[2] U. S. Patents 2,263,175-6, to Tide Water Assoc. Oil Co.
[3] Shabaker, Houdry Pioneer **3**, No. 1 (1948).
[4] Alexander, Proc. Am. Petroleum Inst. (III) **27**, 61 (1947).
[5] Conn and Connally, Ind. Eng. Chem. **39**, 1138 (1947). Ries, Paper presented to Div. Petroleum Chem. ACS, March, 1950.
[6] Shankland and Smitkons, Proc. Am. Petroleum Inst. (III) **27**, 57 (1947).
[7] Mills, Ind. Eng. Chem. **42**, 182 (1950).
[8] Wrightson, Anal. Chem. **21**, 1543 (1949). Carlson and Cumm, Anal. Chem. **22**, 1116 (1950). Karshmer, Proc. Am. Petroleum Inst. (III) **29M**, 72 (1949). Murray and Plagge, Am. Petroleum Inst. (III) **29M**, 84 (1949). Snyder and Clark, Am. Petroleum Inst. (III) **29M**, 104 (1949).
[9] Conn and Brackin, Ind. Eng. Chem. **41**, 1717 (1949).
[10] Davidson, Petroleum Refiner **26**, No. 9, 663 (1947).

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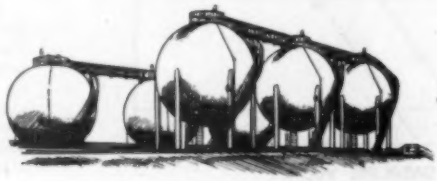

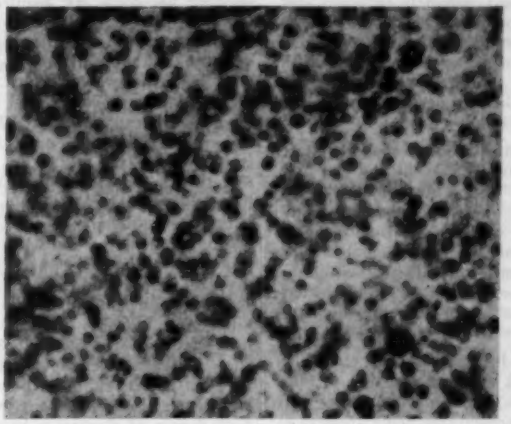

Figure 1.
Bitumen Emulsion. Mag. 750:1

ASPHALTIC EMULSIONS for Road and Industrial Uses

DR. W. BIERHALTER

Translation by Edwin J. Barth, Petroleum Technologist

ASPHALTS — both as heated liquids and in the form of oil emulsions in water—are extensively employed for road building and varied industrial purposes. This article discusses in general terms the manufacture, behaviour, and application of bitumen emulsions, and cites some of the advantages of the emulsions over other methods of application.

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METHODS for emulsifying asphalts, and the practical use of asphalt-emulsions were already known before World War I. Their value came to the fore in the mid-1920's as this period experienced an appreciable increase in highway construction, during which the use of asphalt emulsions expanded in like degree.

The reasons for endeavoring to emulsify asphalt in water were quite obvious. As is known, paving asphalts which are extensively the residues from petroleum distillation are not applicable for paving purposes unless heated to a temperature of approximately 320°-360° F., whereas asphalt in emulsified form is a free-flowing liquid at ordinary temperatures; warming or heating emulsions is not necessary in their application.

Besides this important advantage mentioned above there is another very practical aspect in favor of asphalt emulsions, namely, it is well known that the use of asphalts in paving construction requires and pre-supposes that the mineral components be thoroughly dry or dried before mixing with or application of the binder, since adhesion of bituminous materials is nil on damp or wet surfaces. In contrast to such preliminary drying, asphalt emulsions are successfully employed on damp or wet aggregate during construction, eliminating the expense of drying and preheating. One can employ emulsions under conditions not possible with heated or molten asphalts.

It is worthwhile to clarify the term "emulsion" in a study of the nature of asphalt emulsions and their action in use.

When two immiscible liquids, such as oil and water, are in contact during vigorous agitation, a mixture of both substances results, which will contain the oil in the form of small droplets dispersed in the water. Such a mixture is called an emulsion; that is, the oil is emulsified with water. When agitation ceases both oil and water will have separated in relatively short time into two liquid layers—the lighter or lower specific gravity material rising to the top, the heavier liquid settling below. Characteristic changes in the composition of the two components have not occurred during this manipulation. The oil has, however, most markedly assumed another physical form, since during agitation it has now become broken up or dispersed in water in the form of minute droplets.

An emulsion, therefore, does not present to us any particular substance or group of substances, but merely another form or condition of this substance. Emulsions made as thus described by mere shaking or other mechanical means are stable for only very short periods, if at all, since the emulsified component—in this case the oil—has the tendency to unite into bulk oil the many individual oil droplets. This is due to its specific surface tension. Substances are known which work counter to this tendency to unite the droplets, and which preserve a truly emulsified condition for long-time periods. These materials are known as emulsifiers and are added to the water before making the emulsion.

As to emulsifiers, the soaps comprise the bulk of compounds useful in emulsification processes. As is well known, the soaps are compounds of fatty acids usually with sodium or potassium, and are designated as soda or potash soaps. The usual washing soaps are the soda soaps while common lubricant greases contain usually the lime, lithium soaps, etc. The soda, potash and similar alkali soaps have the property to emulsify substances, usually insoluble in water, which is also why they are cleansing agents.

Besides the soaps, other substances,

such as caustic soda, caustic potash, ammonia and carbonate solutions also possess emulsifying properties to a degree. Suspensions or slimes of clay in water, as well as solutions of protein matter of plant and animal origin, show similar properties for specific type emulsions.

The various kinds of emulsifiers are not all equally efficient and can give emulsions of peculiar and varying properties. The art of producing emulsions lies in one's ability to choose just the correct type of emulsifier so that the emulsion will possess the desired properties, suited to the particular application, or use, and which can be satisfactorily manufactured.

The production of asphalt emulsions as typified by the conversion of bulk asphalt into stable droplets of asphalt in water, presents the same problem as emulsifying oil in water, even though the asphalts are not always as fluid as most oils; both problems require a similar set of conditions in emulsification processes. The asphalts of low melting-point are, however, when molten liquids, of extreme vicosity. Nevertheless, our general definition of emulsions as oily materials (insoluble in water) dispersed in water also includes super-viscous liquids, such as molten or liquefied asphalts.

Incidentally, it must be stated, however, that asphalt cannot be emulsified as can an oil, in water by merely shaking it up or stirring in water since viscosity alone practically prevents any disintegration into small droplets. Emulsification at any time is only possible provided the asphalt is in a thoroughly liquid condition; this fluidity is obtained by heating to 190°-250° F., with the usual asphalts, and this temperature is commonly employed.

To the above-mentioned emulsifiers should be added materials such as rosin and various rosin-oils—rosin being quite popular. It is a hard resin remaining from the distillation of crude turpentine. Similarly popular also is tall-oil, a product of the wood-pulp industry.

Preparation of the Soap

The first step in the preparation of asphalt emulsions is the preparation of the soap, known as saponification; rosin or tall-oil is reacted and heated with the required amount of alkali, and stirring continued until saponification is completed. The soap is next diluted to the desired degree and water content and is ready for use.

It is desired, for example, to prepare 1000 kilos of emulsion to contain 50 percent asphalt; 500 kilos of asphalt and 500 kilos of aqueous soap solution are therefore required. The latter is placed in a steam-jacketed kettle fitted with stirring blades or other type of agitators, and is brought to a temperature of 140°-160° F. During continuous agitation 500 kilos of the asphalt, heated to about 190°-270° F. is slowly added, and continuing the stirring some minutes after all the asphalt has been added. A dark to light chocolate brown liquid results, remaining fluid in the cold.

Microscopic examination of the product reveals the asphalt as small droplets dispersed in the water; Figure 1 presents an emulsion under a magnification of 750:1; the tiny droplets have been measured and normally show a diameter of a few thousandths of a millimeter. (25 mm. 1 inch.) Asphalt emulsions with an extremely high degree of dispersion have shown particle sizes as small as 1-4 microns (1 micron, 1-1000 millimeter); normal or a common particle size is of the order of 5-8 microns. Some particular types of emulsions show a fairly coarse dispersion of the asphalt, with a particle size quite high, such as in ranges of 10-20 microns. The color of a prepared emulsion is often an indication of the particle size of the dispersed asphalt, the light brown colored emulsions usually possessing very small, and the almost black colored emulsions large particle size of the dispersed asphalt.

In this description of emulsion manufacture we have only pointed out the most salient features of the emulsification process, and have not described the many details that need be considered. To do this would be beyond the limits of this paper. For instance, there are quite a series of factors to be considered in the manufacturing process. For one, the origin and kind of asphalt to be used is most important. There are asphalts that are most easily emulsified due to their composition, and again one finds bitumens difficult to emulsify and a few where it is impossible, under normal operating conditions to make even a crude unstable dispersion.

Also, the type and quantity of the emulsifier is of great importance. Further, the construction of the kettle, its type of agitator, speed of stirring, and time taken to add the asphalt play an important part in the success or failure to produce good emulsions. Finally, it can be said the end-result depends to a large degree on the practical knowledge possessed by the particular operator or engineer.

It has been mentioned that the origin or nature of the asphalt plays an important part in making emulsions successfully. A few remarks concerning the ability or ease with which some asphalts produce either a good or poor emulsion can be made. It can be said that "good" emulsifiable asphalts can already be easily emulsified with an ordinary laboratory stirrer, with ordinary caustic alkali solutions, without the need or use of additional or other kind of emulsifying agent. To be sure such emulsions are most apt to be unstable, breaking down in relatively short time. But by the behavior of the emulsion or how the emulsification proceeds by the use of caustic alkali alone, with the use of an unknown asphalt, one can definitely judge the inherent emulsifying properties of the latter.

Salt Content Tests

Asphalts of appreciable salt content are not suitable for making bitumen emulsions. Salts present in the asphalt, derived from the crude oil, and which remain in the asphalt during crude distillation, are powerful agents in preventing emulsification. It is, therefore, important to test the asphalt to be used in the process for "salt content."

The selection of emulsifiers comprises economic as well as chemical factors and consideration. A few of these items will be pointed out. Besides price, one must also consider the lowest or optimum least quantity of soap or emulsifier found necessary to make the emulsion economically. One can judge the fatty oil used in the emulsifier by means of the saponification number; those of high saponification number will be the most efficient and economical. The usual types of rosin and tall-oil quite commonly in use, show a value of 150-180. In the case of normal asphalt emulsions the fatty constituent or fat-acid-oil constituent of the emulsifier ranges between 0.5 to 1.0 percent based on the finished emulsion.

Kettles in which the process is carried out should be equipped with the type of agitators affording the most thorough or intensive mixing and contact of the asphalt and soap solution. A strong beating action is to be avoided, which may lead to foaming; emulsions containing considerable foam are difficult to draw off, and usually form an asphalt skin or film in storage.

Colloid mills have given outstanding performance in this respect, one of the well known types being the Hurrel mill. These mills show a higher thruput than plant agitator-type equipment and furnish a pronounced intimate mixing of asphalt and soap solution, yielding good emulsions even with asphalts which will not emulsify in ordinary plant stirring equipment.

Electric current consumption of the

mill-type equipment is relatively high compared with those needed for ordinary agitation or plant stirrer equipment. Furthermore, the asphalt must be fed to the mill continuously in known quantities and well controlled speed during production; there are technical difficulties in feeding accurately, the two streams of molten asphalt and soap-solution in a continuous manner, as slight fluctuations in relative quantities are practically unavoidable.

How Emulsions Perform

The performance of emulsions, or their behavior in practical application is recognizable in two steps or phases —first, their ability to break and their ability to bind to the aggregate or the coating or binding phase.

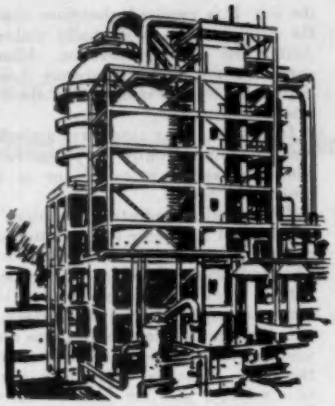
Our understanding as to why or how emulsions give good performance is made possible by a study of these two steps through which the emulsion proceeds in practical application. It is of value to discuss this at some length.

In the case of asphalt emulsions it is only the asphalt contained in them which is the binder or the adhesive. The water which is incidentally present, in the form of a dilute soap solution, has the function to bring the asphalt in a usable form in the cold to the point of application. The asphalt emulsion as such has no binding properties. The latter only become evident when the emulsion is used, during which a separation of asphalt and water takes place. This separation and disturbance in the phases is called "break." The emulsion is then said to be "broken."

Where asphalt emulsions are sprayed or mixed with the mineral aggregate, as in paving practice, a part of the water in the emulsion is taken up by the aggregate. A deficiency of water in the emulsion results, and at some low critical point this is insufficient to maintain the asphalt in dispersed form; the asphalt particles exert the natural tendency to agglomerate into bulk asphalt.

The dispersed asphalt in emulsions is thus flocculated out during mixing with stone, etc., and in that stage it asserts its function and acts as the binder. One can follow and easily observe the transition by the appearance of the black color on the aggregate or the like while before the agglomeration there was noted the brown color of the true emulsion.

The separated water evaporates in a short time, dependent somewhat on weather conditions. Low temperatures and high humidity retard evaporation, while dry warm air aids in the removal of the water. The "break" is complete



once all water has disappeared.

As to the bitumen thus separated, it can be said that its properties are practically the same as the asphalt used in preparation of the emulsion. However, some or all of the fatty acid derived emulsifier will be present, though in such small quantity as not to affect the properties of the asphalt to any degree. Emulsions prepared hastily or with resistant asphalts and made with an unduly large precent of emulsifier have been known to "break" into an adhesive binder which later washes off and disappears from the aggregate during the first signs of rainy weather. Such binders thus take up water once more, lose their adhesiveness, and re-emulsify into soluble liquid. Properly prepared, no emulsion will show this tendency.

The "break" tendency or speed or break-up of asphalt emulsions can be controlled by the type and quantity of the emulsifier; by such controls "rapid breaking," and "slow breaking" emulsions are prepared. A fast breaking emulsion is quite popular where the type of work requires a quick separation of binder asphalt. For other cases it is feasible to have the asphalt separate slowly.

A special class of asphalt emulsions can be prepared which are known as "stable emulsions," or "stabilized." Here the asphalt has normally no tendency to precipitate. The "break" phenomenon is not noticeable and occurs as the emulsion slowly dries out. These emulsions behave like any solutions of asphalt in solvents such as benzole, naphtha, etc., and upon drying yield the binder film of asphalt. This property is desirable again in special cases of application.

Emulsions of this type are prepared with a different type of emulsifier than the materials generally used. As a matter of fact, no true emulsifier is used, such as soaps, or other water-soluble phase liquids. The substances used in the preparation of this type of emulsion are water-insoluble materials, such as humic acid, colloidal clays of various sorts, etc., as well as organic substances such as casein, blood albumen, globulin, or other pasty or mucilaginous substances.

These emulsions stabilized in this manner are differentiated from the water-soluble usual types by their almost black appearance, due to the relatively larger particle size of the dispersed asphalt.

A few of the salient points concerning the properties of emulsions are in order.

The practical value of an emulsion is firstly very dependent on the content of asphalt so that the guarantee of the producer as to available asphalt should check with the actual quantities of asphalt present. Asphalt emulsions normally should contain between 50-60 percent asphalt, depending on the uses to which it will be put. Paving emulsions are required to contain at least 55 percent asphalt, the industrial emulsions showing about 50-55 percent of bitumen content.

Storage stability is also a most important factor; the emulsion must be ready for use after days or weeks of storage, and show no evidences of asphalt separation in drums or other container. There is a limit of course to the period of time for storage without separation beyond which most emulsions may "break." Usually, a period of at least eight weeks is considered practical. During this time a concentration of asphalt particles will probably become manifest in the lower strata of the emulsion kept in storage due to the difference of the specific gravity of the water solution and the dispersed asphalt particles. One must be able to redistribute the stratified layer of dispersed asphalt, and this can be done by thorough agitation. In a properly made emulsion stratification is prevented by occasional agitation, assuming, of course, that no actual "break" has taken place during storage.

As already mentioned, another feature of a satisfactory emulsion is that the bitumen broken out of an emulsion during application must be impervious to water, and must show no tendency to re-emulsify.

Standard specifications exist, which show the limits required for the various tests, such as the DIN specifications and others.

Paving Industry Big User

The paving industry is the largest user of asphalt emulsions. During 1938 in Germany 40 percent of all as-

phalt used in paving was in emulsion form. Here it is a big advantage since heating of the usual bulk asphalts or road oils is eliminated; the necessity of preheating the mineral aggregate in order first to dry it is also avoided. Paving with emulsions can be carried out with damp or wet aggregate.

Asphalt emulsions are most commonly employed in the surface treatment of roads — a low cost and economical treatment on rural roads; the rural system of roads is extensive, and asphalt emulsions provide a cheap means of applying high grade binder. The method is one of spraying the emulsion on well-rolled aggregate, applying a light dust layer, followed by rolling. A good road surface is formed at low cost, suitable for general traffic and sufficiently protected for the load-bearing aggregate and sub-grade below. For repair jobs, where traffic interruption and delays is to be minimized the asphalt emulsions find most ready use; the whole job of repairing and patching of course is essentially based on the excellent property of fluidity of these liquids in the cold, and controlled ability to "break" in short order (quick-break emulsions).

Where fairly heavy aggregate, and new construction is under way, it is desirable to obtain long-lasting road beds and wearing surfaces, especially for heavy traffic. In this type of construction the "slow-break" emulsions are used since the wearing surface is prepared by mixing at the plant or on the job. It is required, therefore, that the emulsion be substantially stable during the mixing operation. After spreading the treated aggregate it is thoroughly rolled immediately thereafter.

In the building industry asphalt emulsions find ready application wherever asphalt is called for as a bituminous binder.

The so-called "industrial emulsions" are those of the stable type mentioned earlier, as having a rather black color. Their adaptation in indusrty is widespread. They are commonly used in insulation equipment on flat surfaces, etc., where hot asphalt applications are unsuited, and as pipe coatings, or in the form of pastes which may contain solvents and the like. In cases where dry surfaces are treated the emulsion, in paste form may contain little or no water, being made up with a non-aqueous quick-drying solvent. Or again, they may be applied to damp surfaces, using those types containing water. In general these emulsions are painted or troweled on the surface to be protected.

Another form of these materials is where the dark-colored emulsions are prepared as pastes containing asbestos fiber; these materials once applied set to a hard waterproof coating, which will wear well mechanically; that is, where high mechanical strength and a tough wearing surface, more or less fireproof, is called for.

The cement and building block industry employ various types of asphalt emulsions to obtain greater density and to obtain impervious and well waterproofed blocks, boards, slabs, etc. Such prepared articles are most resistant to water and chemicals, since asphalt itself is inert to most corrosive substances, including industrial wastes. The emulsions are used either as additions to the water used for mixing the concrete, or to the concrete or clay mixture just before moulding or laying.

The paper industry is quite a large consumer of various types of asphalt emulsions in the production of waterproofed or water-repellent cardboards, and technical sheets, heavy paper, etc. The emulsion is added to the thick fiber paste before the mass is formed into sheets. During the mixing the asphalt coagulates onto the fiber, as well as filling the spaces between the fibers; the latter results in a paper of absolute "water-proofed" qualities, and increased tensile strength. A variation of this application is in the manufacture of fiber-board, where the water-resistant properties of asphalt are highly desirable in building construction.

The worldwide patent literature reveals many other uses for these versatile asphalt emulsions, such as in water-proofing boat canvas (sails), in floor tiling, in the finishing of so-called artificial leather, derived from waste scrap leather, and innumerable other uses.

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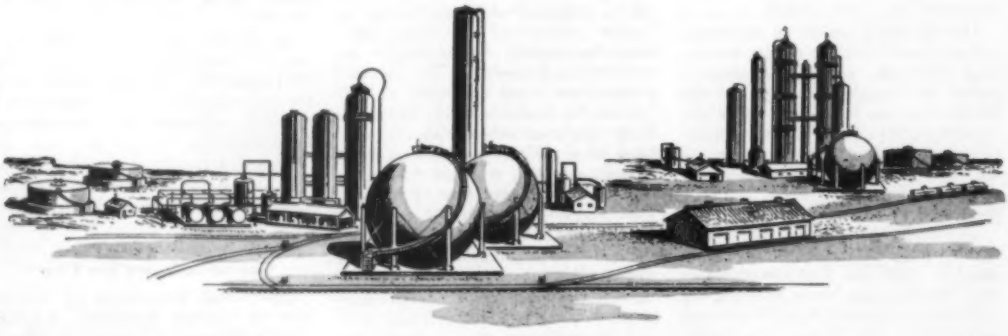

DISCUSSED in this three-part series are the chemical conversions effected in refining processes currently in use for the manufacturer of components of motor and aviation gasolines. Especially treated is the behavior of various hydrocarbon types rather than of individual compounds because of the complex composition of petroleum fractions. To show the significance in refining operations of the processes described, calculations are presented to show the effect of the progressive application of various processes on the yield and octane quality of motor and aviation fuels for a given refinery situation.

Part II describes some of the major processes now in commercial use.

Production of High-Octane Gasoline Components

PART II. Processes

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SOME of the major processes in commercial use for the production of gasolines from crude petroleum and for improving gasoline octane quality are discussed under the several headings:

Primary Fractionation of Crude

The yield and quality of gasoline and other stocks obtained from individual crudes by distillation vary considerably with crude source. Conventional distillation of an average crude mixture yields the following fractions: propane and lighter gases, 1 percent; C_4-400° F. gasoline, 25 percent; middle distillates (kerosine, burner oil, diesel oil), 12 percent; gas oils (for cracking), 37 percent; lube oil stocks (requiring further finishing treatment) 7 percent; residuum, 18 percent.

The C_4-400° F. gasoline obtained by straight distillation of the above crude has an octane rating of about 55 by the Research Method and about 53 by the Motor Method (ASTM D-357-47); when 1.0 cc. of tetraethyl lead (TEL) per gallon is added to this gasoline, these octane ratings are increased to about 65 and 63, respectively. In general, the Research rating is considered to be indicative of performance under low-speed engine conditions, whereas the motor rating is considered to be more indicative of performance under high-speed engine conditions. Both of these octane rating methods are in common use.

A typical straight-run gasoline contains 52 percent of paraffins, 37 percent of cycloparaffins, and 11 percent of aromatic hydrocarbons, and the octane quality of this gasoline usually is too low to allow direct inclusion in present-day, high quality specification gasolines. Various fractions of the straight run gasoline usually are further processed to improve octane quality.

Conversion of Gas Oils

Usually a balance is maintained between production of gasoline and other petroleum products, particularly the middle distillates, but a substantial portion of the gas oil in crude is converted to gasoline by cracking. Catalytic cracking processes are steadily replacing the older thermal cracking process because of the greatly superior octane quality of the catalytically cracked gasoline and the higher yields of light olefins from the catalytic processes for subsequent processing to premium quality aviation and motor gasolines or to special products such as synthetic rubber. The three common forms of the catalytic cracking process are the fluid, fixed-bed, and moving bed types of operation. Of these types, the fluid process is most widely used. In the fluid process, a mixture of hot oil and powdered catalyst is fluidized in the reaction vessel by means of the vaporized oil supplemented by steam or inert gas injection. The catalyst, after separation from the reaction products, is regenerated in an adjoining vessel by controlled burning to remove coke and is then recycled to the reactor. This cracking operation usually is conducted at 900-1000° F. temperature and at 5-20 pounds gauge pressure. The catalyst commonly used is a silica-alumina type of natural or synthetic clay.

TABLE 11
Comparison of Thermal and Catalytic Cracking of Gas Oil

Method of Cracking	Thermal	Catalytic
Temperature, °F.	915	950
Pressure, p.s.i.g.	750	15
Product Yields, Vol. %		
C_3 and Lighter	7.4	6.8
C_4 Fraction	4.5	10.6
C_5-430° F., Naphtha	40.1	35.3
Total C_5-430° F.	44.6	45.9
430° F.-and-Heavier	51.5	51.5
Coke	0.2	3.2
Product Inspections:		
C_4 Fraction, Vol. Percent Unsaturates	27	56
C_5-430° F., Naphtha Research Octane Number	70	94
Motor Octane Number	63	80

The thermal cracking process is carried out in coil-and-drum or coil-only cracking units at 900-1000° F. temperature and at 200/1000 pounds pressure. The product yields and naphtha octane quality from thermal and catalytic cracking of a typical gas oil to a common conversion level are compared in Table 11. The higher octane quality of the catalytic naphtha is due to higher concentrations of the desirable aromatics, olefins, and branched-chain acyclics.

Conversion of Residuum

Thermal Cracking. The conventional method of producing gasoline from crude residuum is by thermal cracking in coil-and-drum and coil-only units. The yield of C_4-400° F. naphtha for gasoline from this operation usually is limited to about 15 percent by the practical consideration of obtaining extended run lengths between periodic shutdowns for removal of coke produced in the reaction vessels or coil during the process. The naphtha produced in this operation usually contains 30-40 percent of olefins, minor amounts of aromatic and naphthene ring compounds, and a sizeable quantity of paraffins. Since the paraffins and olefins are lightly branched, containing an average of about one methyl group as a side chain per molecule, this naphtha usually has an octane rating of only about 67 Research and 60 Motor. The residuum cracking operation also produces about 15 percent of a cycle gas oil fraction which can be either treated to produce finished

heating oil or thermally cracked in a long coil-only unit, with recycling, to obtain an ultimate C_4-400° F. naphtha yield of about 55 percent, along with a high yield of dry gas (propane-and-lighter). The naphtha from cycle oil cracking contains slightly more aromatic and branched aliphatic compounds than does the naphtha produced directly from residuum cracking, and has an octane rating of about 75 Research and 67 Motor. These cracking operations normally are carried out at 200-1000 pounds pressure. A temperature of about 900° F. is used for residuum cracking, where as a temperature of 950-1050° F. usually is used when cracking cycle gas oil.

Deasphalting. Deasphalting involves the removal of heavy asphaltic materials from residuum, producing either lube oil stocks or a clean heavy gas oil fraction suitable for cracking. The deasphalted oil from non-lube residuum usually is charged to catalytic cracking rather than thermal cracking because of the much higher octane quality of the catalytic naphtha and the more favorable yields of butenes and heating oil fractions. The deasphalting step involves contacting the residuum with 4-6 volumes of a light diluent such as propane. The propane is flashed from the deasphalted oil and recycled. This deasphalting operation usually is conducted at temperatures in the range of 100-170° F., and at 300-400 pounds pressure.

Coking. Several coking processes are available for converting residuum to lighter products. In most of these processes the preheated residuum is heated batch-wise at 900-1000° F. in a gas-fired oven, from which oil vapors are flashed at approximately atmospheric pressure to a fractionating column. The oven is opened between runs for coke removal. Typical yields from coking a 16 percent crude residuum, shown in Table 12, are 12 percent of 60 Research octane gasoline and 70 percent of gas oil suitable for cracking stock. The coke produced is of unsatisfactory quality for metallurgical uses.

TABLE 12

Yields from Coking of a 16 Percent Residuum

Yield Basis	On Residuum	On Crude
Gasoline, Volume, Percent	12	2
Gas Oil, Volume, Percent	70	11
Dry Gas, Weight, Percent	6	1
Coke, Weight, Percent	20	3

Conversion of Light Ends

Polymerization. Catalytic polymerization processes for producing gasoline from light olefins (propene, butenes, pentenes) are classified as selective and non-selective processes. The selective polymer usually is either a dimer of isobutene or a co-dimer of isobutene and a normal butene, produced by reacting a refinery cracked C_4 fraction under carefully controlled conditions. The dimer has slightly higher octane ratings than does the co-dimer, but production of the co-dimer usually is preferred because the co-dimer yield is double that of dimer from a typical cracked C_4 stock. The selective polymer has a Research octane rating of 99-101 and hence is a desirable component of premium quality motor gasolines. The selective polymer can be hydrogenated to obtain a highly-branched hydropolymer which is suitable for use in high grade aviation gasolines. The non-selective polymer is usually produced by reacting a mixture of refinery butenes and propene; sometimes propene is polymerized alone, and sometimes a limited quantity of pentenes is included in the feed. Thus, it is possible to obtain much higher yields of non-selective polymer than of selective polymer from a cracked light ends mixture. The non-selective polymer is about equal to the selective polymer in octane rating for motor gasoline, having a Research octane rating of 96-98, but is unsuitable for hydrogenation to produce a premium quality aviation gasoline component because the olefins contained therein are predominantly the lightly branched ones; its Motor octane rating after hydrogenation is only about 80.

The selective polymerization process commonly is carried out at temperatures of 350-400° F. and at pressures of 600-1000 pounds, using catalysts such as phosphoric acid, copper pyrophosphate, or silica-alumina. Tubular reactors surrounded with a cooling medium to remove the heat generated by the exothermic polymerization reaction usually are employed to maintain the careful temperature control required in the selective process. The non-selective process usually is conducted in chamber-type reactors at 400-475° F. temperatures and 200-1000 pounds pressure. Higher yields are obtained at increased pressures. The commonly used catalysts are phosphoric acid-on-kieselguhr and copper pyrophosphate-on-charcoal.

The selective polymerization of butenes also can be carried out using 60-70 percent aqueous sulfuric acid as catalyst. Operation at low temperatures (70-80° F.) produces the isobutene dimer, whereas operation at higher temperatures (140-170° F.) produces the co-dimer of isobutene and normal butene. Nominal pressures are used in this process.

The aforementioned polymerization processes utilize olefins only. A non-catalytic, thermal polymerization process uses high pressures (1200-1700 pounds) and high temperatures (1000-1100° F.) to polymerize propane and butanes, alone or in mixture with propene and butenes. The process depends on cracking of the propane and butanes, followed by polymerization of the resulting olefins, to yield a high volatility polymer gasoline having a Research octane rating of about 88. A large portion of the propane and butane charged to the process remains unconverted after a single pass through the reaction vessel; usually this unreacted propane and butane is separated from the product and recycled to the process.

Alkylation. Various forms of the alkylation process are widely used for reacting isobutane with light olefins obtained from cracking operations to produce higher boiling isoparaffins of exceptional octane quality. When adequate supplies of isobutane can be made available, alkylation has the advantage over polymerization of producing a much higher yield of gasoline from the olefins. The alkylate is lower in Research octane rating than non-selective polymer, but is much higher in Motor octane rating and greatly superior in its octane response to addition of tetraethyl lead. Alkylates are particularly suitable components for aviation gasoline, whereas polymer gasoline is unsuitable for aviation use because of its low octane ratings under the Aviation (ASTM D-614-47T) and Supercharge rich (ASTM D-909-47T) octane tests and its gum-forming tendencies in long time storage.

The most commonly used alkylation process employs concentrated sulfuric acid as a catalyst. Propene, butenes, and pentenes are suitable olefins for charging to this process. The olefin stock together with a large excess of isobutane is intimately mixed with approximately an equal volume of sulfuric acid to form a loose emulsion. After a 15-30 minute reaction period, the acid is separated from the hydrocarbons in a settling vessel, and the hydrocarbon is distilled to recover the desired fraction of alkylate product and the excess isobutane which is recycled. In general, the selectivity of the process and the product octane quality are improved by employing a high concentration of isobutane (60 percent) in the reactor, good mixing, and low reaction temperatures. A temperature of 35-40° F. is optimum for butenes alkylation, whereas a temperature of 50-60° F. usually is optimum for propene and pentenes. The required pressure to maintain liquid phase operation is set by the vapor pressure of the reactants at the operating tempera-

ture. The reactor acid is maintained at constant strength by withdrawal of used acid and addition of strong acid at a regular rate. In general, alkylate quality decreases and catalyst consumption increases in the following order of olefins alkylated: butenes, pentenes, propene. Olefin stocks produced by catalytic cracking usually are superior to corresponding olefin stocks produced by thermal cracking as alkylation feed because of their considerably higher olefin concentration and their lower diolefin content. Diolefins cause excessive degradation of the alkylation acid. Yields, octane quality, and acid consumption for typical alkylates produced from the three catalytically cracked olefin feeds are shown in Table 13.

The HF alkylation process employs hydrogen fluoride as catalyst, and is similar to the sulfuric acid process. The same feed stocks are used for both processes; slightly higher temperatures are used with the HF catalyst. Alkylate yields and octane quality are comparable with those obtained using sulfuric acid catalyst; there are minor differences in alkylate composition. HF alkylation produces an appreciable amount of propane product and there are minor variations in the relative proportions of the C_8 and other isomers. The hydrogen fluoride is recycled, and catalyst consumption is very low. As a result, it is usually found that the HF process is more economical for smaller plants, producing up to about 1200 barrels per day of alkylate, because of the saving in acid recovery and regeneration facilities. For plants producing more than 1200 barrels per day of alkylate, the sulfuric acid process usually is more economical.

Ethene isobutane alkylation can be carried out successfully with an aluminum chloride catalyst. The catalyst may be used in either of two forms: 1) a fixed-bed of alumina or bauxite impregnated with about 10 percent $AlCl_3$,[19] or 2) a liquid hydrocarbon-$AlCl_3$ complex.[20] The operation usually is carried out at about 115° F. temperature and 300 pounds pressure, using an isobutane/ethene feed ratio of about 5:1. The alkylate yield is about 144 volume percent based on the ethylene. This alkylate contains about 98 percent of C_5-350° F. fraction and contains about 70 percent of 2,3-dimethylbutane, a compound having exceptional octane quality characteristics. The C_5-350° F. ethylene alkylate has a Motor octane rating of about 94, and an Aviation octane rating, with 4.0 cc. TEL per gallon, of about 112. Minor quantities of propene can be alkylated along with the ethene in this process.

The thermal alkylation of isobutane with ethene has been carried out in high pressure furnace tubes operated at about 950° F. and 3000-5000 pounds pressure. In this process it is necessary to maintain an extremely high ratio of isobutane to ethene in the reaction zone in order to retard olefin polymerization reactions. The alkylate from this process has a Motor octane rating of about 94, and the principal reaction product is 2,2-dimethylbutane. Since alkylate yield per pass is rather low, recycling usually is employed.

When alkylation operations are conducted on a large scale, it usually becomes necessary to isomerize normal butane in order to obtain an adequate supply of isobutane for alkylation requirements. In the most widely used butane isomerization process, normal butane containing 2-6 percent of anhydrous hydrogen chloride as a promoter is passed in the vapor phase through a fixed catalyst bed comprising 10-16 percent of aluminum chloride on bauxite. The operation usually is conducted at about 250-350° F. temperature and 250 pounds pressure. A conversion of normal butane to isobutane of 40-50 percent per pass is obtained, at a butane selectivity of about 95 percent. The product is fractionated by distillation, and the normal butane is recycled.

Upgrading Naphtha Fractions for Gasoline

Thermal Reforming. The thermal reforming process is commonly used to upgrade the octane quality of virgin naphtha gasoline fractions. The naphtha product contains a large quantity of lightly branched olefins and paraffins, and a small quantity of aromatics and naphthenes; large quantities of butanes and dry gas are produced. Fairly severe thermal reforming of an average 50-octane number 200-400° F. virgin naphtha will yield about 80 percent of a C_4-400° F. naphtha fraction having a Research octane number of about 80 and Motor octane number of about 70. The operation is carried out in a coil-only cracking unit, usually at a temperature of about 1050° F. and 200-1000 pounds pressure.

Thermal Recracking. The cracked naphthas produced in thermal cracking of gas oils and residuum are relatively low in octane quality. The octane quality, as well as volatility, can be increased, at the expense of yield, by recracking the heavier fractions of these naphthas in coil-only or coil-and-drum thermal units. For example, recracking of an average 180-400° F. cracked naphtha fraction having a 62 Research octane rating will yield about 85 percent of a C_4-400° F. naphtha having a 78 Research octane rating or about 75 percent of a C_4-400° F. naphtha having an 82 Research octane rating.

A special form of recycle thermal cracking operation is represented by the "polyforming" and "gas reversion" processes. These two processes differ only in the mechanics of operation. In this operation, butane-butene and propane-propene stocks from cracking operations or from an outside source are charged along with heavy virgin naphtha or gas oil to a standard thermal cracking operation. Under these conditions, a portion of the recycled C_3-C_4 components are converted to higher boiling gasoline fractions. The unconverted C_3 and C_4 usually is recycled. The chemical reactions involved are analogous to those of the thermal polymerization process already described. The process results in an increased yield of gasoline at the expense of light ends. The octane quality of the "polyformed" gasoline is higher than that of the cracked gasoline from conventional thermal reforming or cracking.

Catalytic Aftertreating. Several catalytic processes are available for upgrading the octane quality of thermally cracked naphtha. The octane improvement usually is in the order of 4 to 5 octane units, and the liquid yields are high. One example is the "Isoforming" process, which employs a silica-alumina or a synthetic zeolite catalyst in a fixed-bed operation. This process employs high space velocities and is usually carried out at about 20 pounds pressure and 950° F. At this severity level, about 2 percent of dry gas and 2 percent of heavy polymer are produced with an average cracked naphtha feed. The catalyst is regenerated periodically by burning in the presence of air;

TABLE 13

Alkylation of Isobutane with Various Olefins

Type of Alkylate	Butenes	Pentenes	Propene
Yield of Total Alkylate, Volume, Percent of Olefins	170	189	160
C_5-350° F. Alkylate, Volume, Percent of Total Alkylate	97	91	97
Motor Octane Number of C_5-350° F. Alkylate	94	90.5	89
Aviation Octane Number with 4 cc. TEL/Gal.	106.2	105.6	104.7
Supercharge Rich Octane Number with 4 cc. TEL/Gal.	Iso* + 4.0	Iso + 2.0	Iso + 1.55
R.V.P. of C_5-350° F. Alkylate	3.5	.....	4.0
Acid Consumption, Lb./Gal. Total Alkylate	1.0	1.8	3.5

* Equivalent to Iso-octane plus X cc. TEL/per gallon.

two catalyst vessels are alternated between on-stream and regeneration to provide continuous operation. The "cycloversion" process, which is a form of a fixed-bed catalytic cracking process employing a bauxite catalyst, functions similarly.

Hydroforming. The hydroforming process is a very important method of upgrading the octane quality of virgin naphtha fractions in the 200-400° F. boiling range. The principal chemical reaction involved is the catalytic dehydrogenation of cyclohexane ring compounds to the corresponding aromatic hydrocarbon compounds; for example, methylcyclohexane is converted to toluene, dimethylcyclohexanes are converted to xylenes, etc. Secondary reactions, such as thermal cracking, isomerization, and aromatization of paraffins occur to a minor extent. Hydroforming has distinct advantages over the competitive thermal reforming process: 1) hydroforming produces a higher gasoline yield of a given octane quality, or a higher octane quality for a given yield; 2) it effects about 90 percent desulfurization of the naphtha, resulting in improved TEL response; 3) it produces a gum-stable gasoline that requires no further finishing.

The octane improvement obtainable by hydroforming varies with the composition of the naphtha feed, as influenced by crude source. In general, the higher boiling naphtha fractions have a lower starting octane level and show a greater octane improvement on hydroforming; a 250-300° F. naphtha fraction is a more desirable feed than the corresponding 200-250° F. fraction. Hydroforming of an average 50-octane number 200-400° F. wide-cut virgin naphtha at a normal severity level produces about 87 percent yield of C_4-400° F. hydroformate having a Research octane number of about 89 and a Motor octane number of about 79. Higher octane numbers are obtainable at lower yields.

If extremely high octane quality is desired, at the expense of yield, the hydroformate product can be processed to segregate an aromatic concentrate of high purity (95 percent or higher) having exceptional octane characteristics and a 30-40 octane number raffinate fraction which can be thermally reformed to upgrade its octane level. The product yield and octane improvement from this latter operation are comparable to those obtained in conventional thermal reforming of virgin naphtha.

The hydroforming process normally employs a molybdenum oxide-alumina catalyst, and is conducted at temperatures of 900-1000° F. and at a pressure of 200-250 pounds. Hydrogen produced in the naphthene dehydrogenation process is recycled to the extent of about 2000 cubic feet per barrel of feed in order to minimize catalyst carbonization. The catalyst usually is regenerated after 4 to 6 hours of operation by burning off the carbon deposited during the process and then treating with hydrogen. A typical plant consists of four fixed-bed reactors, a pair of which is alternately on-stream and under regeneration. Since the reaction is endothermic, a temperature drop occurs across the adiabatic reactors. To obtain a sufficiently high temperature to support reaction in the second reactor, the naphtha usually is reheated between the reactors, operated in series.

TABLE 14
Superfractionation of C_5-210° F. Virgin Naphtha

Fraction	Volume Percent of Total	ASTM Motor Octane No.
Isohexane	20	81
Normal Hexane	27	52
Isoheptane	40	72
Normal Heptane	13	40
	100	....

Superfractionation. The separation of isobutane from normal butane by distillation in connection with alkylation operations and the distillation of 95 percent isopentane from its mixture with normal pentane for use in aviation gasoline blending are standard commercial procedures.

In the case of virgin naphthas boiling up to about 210° F., a fairly good segregation of high octane and low octane fractions can be effected by precise distillation. Since the naphthas boiling below about 200° F. are not particularly easily upgraded in octane quality by such processes as hydroforming and thermal reforming, superfractionation has particular application in segregating the high-octane fractions of the light naphthas for blending into premium quality gasolines, such as 100/130 Grade aviation gasoline. The usual procedure for fractionating a C_5-210° F. virgin naphtha consists of taking overhead, on three successive towers, the following cuts: 1) a C_5-145° F. isohexane fraction, containing principally a mixture of branched hexane isomers plus cyclopentane; 2) a 145-165° F. normal hexane fraction, containing mostly normal hexane and methylcyclopentane, with minor amounts of adjacent boiling compounds; 3) a 165-195° F. isoheptane fraction, containing principally methylhexanes, dimethylpentanes, and a large quantity of various dimethylcyclopentanes. Some benzene usually appears in each of these three fractions as the result of azeotrope formation. A normal heptane concentrate is taken as bottoms from the final distillation column. Yield, octane, and composition data on the various fractions obtainable when charging an average C_5-210° F. virgin naphtha from mixed light crude are shown in Tables 14 and 15.

Isomerization. The octane quality of the normal pentane and normal hexane fractions obtained in the superfractionation of light virgin naphtha can be effectively upgraded by catalytic isomerization. No satisfactory isomerization process has yet been developed for the normal heptane fraction. The theoretical equilibrium of paraffin isomers as defined by chemical thermodynamics shifts rather sharply in favor of the very highly-branched high-octane components at low tem-

TABLE 15
Infrared Analysis of Nominal 103°-200° F. Virgin Naphtha from Mixed Light Crudes

COMPOUND	Boiling Point, °F.	Volume Percent of Total	PLANT-PRODUCED FRACTIONS		
			Isohexane, Volume Percent	Hexane* Volume Percent	Isoheptane, Volume Percent
Normal Pentane	97	0.5	2.4	....	....
Cyclopentane	121	1.6	7.7	....	....
2,2-Dimethylbutane	121.5	0.5	2.4	....	....
2,3-Dimethylbutane	136.5	1.8	8.6	....	....
2-Methylpentane	140.5	10.6	47.0	2.8	....
3-Methylpentane	146.0	6.9	19.0	12.3	....
Normal Hexane	155.6	20.0	12.2	61.7	....
Methylcyclopentane	161.2	9.6	....	16.5	2.6
Benzene	176.2	2.3	0.7	5.5	3.0
2,3-Dimethylpentane	174.7	0.9	....	0.3	1.5
2,4-Dimethylpentane	176.8	1.2	....	0.4	2.0
Cyclohexane	177.2	13.9	....	0.5	26.0
3,3-Dimethylpentane	186.8	0.4	....	....	0.9
1,1-Dimethylcyclopentane	189.5	1.7	....	....	3.7
2,3-Dimethylpentane	193.0	2.8	....	....	6.2
2-Methylhexane	194.0	6.6	....	....	14.0
t-1,3-Dimethylcyclopentane	195.3	4.4	....	....	9.7
t-1,2-Dimethylcyclopentane	197.5	6.8	....	....	14.0
3-Methylhexane	197.5	5.3	....	....	11.7
3-Ethylpentane	200.2	0.5	....	....	1.0
Normal Heptane	208.8	1.0	....	....	2.2
Methylcyclohexane	213.4	0.6	....	....	1.3
c-1,2-Dimethylcyclopentane	210.7	0.1	....	....	0.2
	....	100.0	100.0	100.0	100.0

* Normal Hexane.

peratures (50-150° F.); it has been found necessary in commercial practice, however, to operate at temperatures of about 200° F. or higher in order to obtain a satisfactory reaction rate in accordance with the chemical kinetics involved.

Several processes are available for the isomerization of normal pentane, all of which are based on processing the pentane in the liquid phase and using aluminum chloride or aluminum bromide as the catalyst. Various commercial processes employ the catalyst in the following forms: 1) a liquid hydrocarbon-aluminum chloride complex containing free aluminum chloride, 2) a fixed-bed of bauxite impregnated with about 10 percent of aluminum chloride, 3) a eutectic melt comprising 4-5 percent aluminum chloride dissolved in antimony trichloride. In each process anhydrous hydrogen chloride is added as a catalyst promoter and hydrogen is introduced to retard catalyst degradation. While each of these processes has certain specific features, all accomplish about 60 percent average conversion of normal pentane to isopentane per pass with peak conversions as high as 80 percent. Typical operating conditions for the fixed-bed process are as follows: temperature, 200° F.; pressure, 300 psig; pentane charge rate, 1.0 V/V/hour; 1.0 weight percent HCl, 1.0 mol percent hydrogen, and 0.2 volume percent of benzene added to the pentane feed. A selectivity to pentanes of 99 percent and the production of 120 gallons of isopentane per pound of aluminum chloride consumed are claimed for the process. The preferred type of operation includes recycling to ultimate yield of isopentane.

The most effective process for the isomerization of hexanes is the "Isomate" process, employing as catalyst an aluminum chloride-hydrocarbon liquid complex. The normal operating conditions for this process are as follows: temperature, 250-275° F.; pressure, 850 psig; HCl concentration, 6 weight percent of feed; space velocity, 1.0 V/V/hour; hydrogen rate, 180 cubic feet per barrel feed; $AlCl_3$ addition, 1.0 pounds per barrel feed. Minor quantities of dry gas, butanes, pentanes, and a heavy alkylate or polymer product are produced in the process; the selectivity to hexanes usually is above 90 percent. The hexane product from once-through operation has an octane rating of about 80 Motor. An octane number of about 86 is theoretically obtainable when excluding the non-paraffin components in the naphtha. The various hexane isomers in the product approach the theoretical equilibrium concentrations with the exception of the compound 2,3-dimethylbutane whose concentration is lower than the theoretical value. The normal hexane stocks distilled from most virgin naphthas contain 5-15 percent of methylcyclopentane and 1-5 percent of benzene. Under reactor conditions the methylcyclopentane is isomerized to cyclohexane to the extent of about 60 percent.

The octane quality of the product can be significantly increased with a moderate loss in yield by means of the "Neohexane" process. In this operation, a dimethylbutane concentrate of about 91 Motor octane number is removed as product, a methylpentane-normal hexane fraction is recycled to the isomerization reactor, and a cyclohexane fraction is withdrawn from the system. Hexane and pentane stocks can be isomerized as a mixture in this process.

Catalytic Aromatization. Catalytic aromatization is another process that has potential application in upgrading the octane quality of the C_6-210° F. virgin naphtha fraction by converting the normal hexane, cyclohexane, and normal heptane contained in this naphtha to the corresponding aromatic hydrocarbons. Certain isoparaffins and cyclopentane derivatives also are converted to aromatics to a small extent. These processes usually employ as catalysts various combinations and modifications of the oxides of such metals as chromium and molybdenum supported on a base such as alumina. The operation usually is conducted at temperatures of 900-1000° F. and 0-50 pounds pressure, with the addition of hydrogen to the process.

Desulfurization. Gasoline stocks from most crudes usually contain sulfur compounds in the concentration range of 0.1 to 0.5 percent. Catalytic desulfurization processes are available which will remove 50-80 percent of the sulfur from cracked gasolines, 70-98 percent from straight-run gasolines, and 90-100 percent from natural gasolines. These processes employ catalysts such as cobalt molybdate, the sulfides of certain heavy metals, and certain clays. Desulfurization improves substantially the response to tetraethyl lead; in the case of high-sulfur naphthas, this improvement frequently is in the order of 8-12 octane units at the 1.0 cc per gallon TEL level.

Production of Triptane. The exceptional octane quality of triptane (2,2,3-trimethylbutane) is well recognized. This hydrocarbon has an octane rating (blending value in paraffinic base fuel) of about 113 by both the Research and Motor methods, and has an aviation fuel performance grade with 4 cc. of tetraethyl lead per gallon of 185/255 (ratio of the Performance Numbers measured by the Aviation and the Supercharge rich test methods). Triptane of 99 percent purity has been produced on a semi-commercial scale in pilot plant units[15], but the economical production of triptane is still in the future. Processes for triptane production have been developed by General Motors Corporation[16], Universal Oil Products Company[17], and the du Pont Company[18], but they are all high-cost processes and the details of operation have not been made generally available. The UOP process selectively converts 2,3,3,-and 2,2,3-trimethylpentanes to triptane by demethylation in the presence of hydrogen and a nickel-kieselguhr catalyst. The General Motors and du Pont processes are based on the production of triptane from substituted ethene in a series of steps.

Hydrogenation of Cracked Naphthas. A low-pressure (200-300 pounds) hydrogenation process employing a metal sulfide catalyst can be used to improve the octane quality of the light fraction (110-210° F.) of catalytically cracked naphtha for use in aviation gasoline. The octane improvement is based largely on an improvement in the response to tetraethyl lead. At the same time, the stability of the gasoline is improved. Hydrogenation increases the Aviation octane rating of this naphtha, at the 4 cc. per gallon tetraethyl lead level, from about 86 to about 96; the Supercharge rating remains about the same. A much smaller octane improvement is effected in the case of heavier fractions of the catalytically cracked naphtha or of corresponding fractions of thermally cracked naphthas, because of the lower concentration of branched-chain structures in these fractions. This process is inapplicable if the naphthas are to be used in motor gasoline, since a reduction in Research octane rating results from the hydrogenation.

End of Part II. Part III will appear in an early issue.

REFERENCES

[15] Kettering, Ind. Eng. Chem., 36, 1070 (1944).

[16] Miller and Lovell, Ibid. 40, 1138 (1948).

[17] Haensel and Ipatieff, J. Am. Chem. Soc., 68, 345 (1946).

[18] Ford and Jacobson, U. S. Patent 2,440,-673 (1948).

[19] Ipatieff and Pines, U. S. Patent 2,398,383.

[20] Thompson and Chenicek, Ind. Eng. Chem., 40, 1265 (1948).

Eurotank Modernized Refinery Now on Stream

THE enlarged and modernized Eurotank Refinery near Hamburg, Germany, recently went on stream. Initially built in 1934, it was formed by welding two sites, one utilized for storage purposes, and the other housed a small refinery processing products for local consumption.

The new refinery, on the south bank of River Elbe to the west of Hamburg, is now a wholly integrated unit, with a nominal thruput capacity of 4,221,075 barrels of crude oil per annum.

The principal process units consist of a Foster Wheeler Topper (5505 barrels per day); a Winkler-Koch combination unit (of 8809 barrels per day crude input), with cracking and reforming capacity for naphtha and residue from the Foster Wheeler unit; gas recovery and stabilization plant and Plumbite treaters. The main products of the refinery comprise regular gasoline, gasoil, fuel oil and bitumen. Plans are under way to manufacture several grades of bitumen.

The initial installation, a Winkler-Koch combined topping, cracking and reforming plant with a thruput capacity of 2,936,400 barrels annually, processing Texas crude, went on stream in 1935. Four years later a distillation unit designed by Foster Wheeler and fabricated by Borsig was erected to provide close specification products from a comprehensive range of imported crudes. The refinery was closed down the following year.

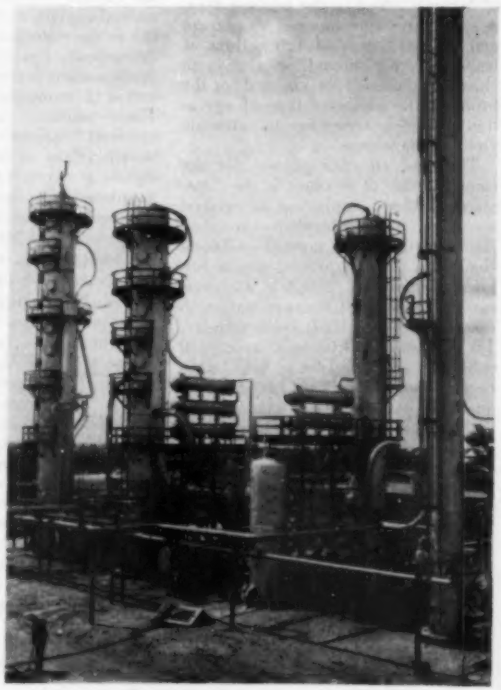
The tank farm was utilized as a bulk storage depot until 1943, when the Hamburg area came under heavy Allied bombing attacks, as a result of which the Eurotank refinery was nearly destroyed. What remained of the refinery was acquired by Anglo-Iranian Oil Company in 1948 when rehabilitation started. The Foster Wheeler unit came on stream in February, 1949, with a thruput capacity of 3303 barrels per day. Work on modernizing and rebuilding the Winkler-Koch unit, the gas recovery plant and treating units went ahead.

Also, modifications to the Foster Wheeler unit were decided upon to step up capacity. With the addition of some heat exchange equipment, and minor alterations to the furnace, the refinry thruput was raised to 5505 barrels per day in mid-1949. By March, 1950, the new refinery began assuming its familiar shape, the revamped tank farms and link-up lines were completed and work concentrated on extensions to the utilities distribution systems, the new laboratory and office buildings and housing for key members of the staff.

Utilities comprise a boiler house with three oil-fired and two coal-fired boilers, a water pumphouse drawing cooling water from the River Elbe through two steam turbine-driven pumps delivering to the cooling water distribution system and an electrical transformer substation. Electricity is procured from the Hamburg grid system.

The Eurotank Refinery and "Olex," Anglo-Iranian's distributing agency in Germany, were recently amalgamated so as to unify control and operation of production and distribution. The refinery enjoys excellent facilities for the dispatch of products by ship, barge or rail-tank car. Its rail siding system was recently re-designed and laid out on the south side parallel to the Reichsbahn.

Top-of-Page Photo—General View of Eurotank refinery. Atmospheric distillation unit, right rear; Winkler Koch combination unit in center; left, caustic dissolving and regeneration plant, sweetening plant and gas recovery plant.



Gas Recovery Unit at Enlarged and Modernized Eurotank Refinery near Hamburg.

MAINTENANCE And OPERATION How To Do It—

HOW TO MAKE—

A Hydrogen Activity Probe

UNDER certain circumstances hydrogen attacks carbon steel with disastrous results. This attack occurs at low temperatures and results from the penetration of hydrogen within the steel to form blisters and cracks.

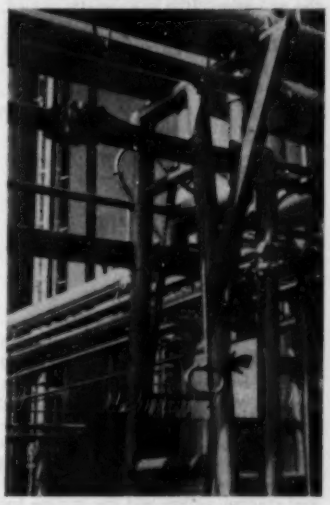
This entire subject was covered in a recent article, "Hydrogen Attack of Steel in Refinery Equipment," by Effinger, Renquist, Wachter, and Wilson, published in PETROLEUM REFINER, May, 1951, page 132. In this article was described the design of a hydrogen activity probe which could be used for measuring the activity of environments which promote hydrogen penetration. This article has attracted considerable interest, and numerous requests have been made for details of construction of the hydrogen activity probes used by Shell Oil Company. In response to these requests Shell offers the sketch shown below of their design together with notes as follows: 1) Probe to be tested under full vacuum by instrument shop after assembly. 2) 500-pound air test to be applied to seal weld on ½-inch bushing. 3) Volume of probe to be determined by instrument shop. 4) Surface area of reduced section 44.5 square cm. or 6.9 square inches. 5) Use seal compound on ¼-inch pipe threads.

Along with this probe design, Shell comments that there would be considerable advantage for the industry to employ standardized probes to permit correlation of the threshold values of hydrogen activity which cause damage to equipment.

HOW TO PROVIDE—

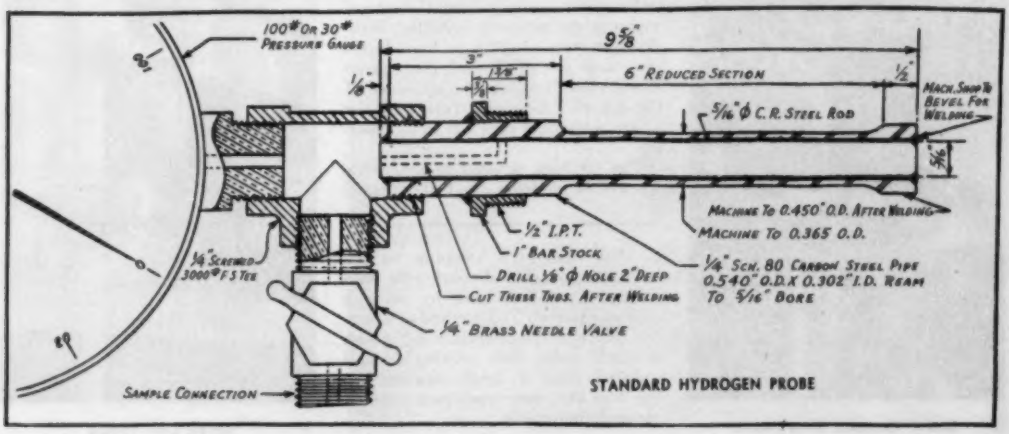
Extension Handle For Overhead Plug Valves

WHEN it is necessary to install lubricated plug valves in an overhead line which is too high for an operator to reach from the pavement, an extension handle can be fashioned which operates quite satisfactory, according to a scheme used at Continental Oil Company, Ventura, Cal.



Extension Handle for Valves

The standard wrench supplied for such valves is flattened at the extreme end of the handle and drilled for a conventional clevis pin. A 'D' handle rod, of convenient length, is made with a clevis connection at the end through



which the pin is inserted to tie the wrench to the long handle. If, for example, this lubricated plug valve is normally open, the handle of the wrench can be attached to the stem in such manner that it parallels the pipe line so the 'D' handle extension will hang at one side out of the path of the operators. If it is normally closed, the wrench can be reversed to bring the 'D' handle on the other side of the walk. Pulling down on the extension either closes, or opens the valve, depending upon the position of the wrench on the valve stem.

HOW TO—

Set Up Containers For Solvents

SUPPLYING solvents to the laboratory sink to clean equipment can be done with a few pieces of pipe and fittings leading from two, or more, surplus gasoline cans which can be obtained in quantities at any war surplus store. The cans are fitted with pipe nipples at the lower end beneath the screw-top closure to attach fittings and control valves and the unions for connecting the supply lines. A support for these cans is installed in the corner of the room above the laboratory bench, high enough to provide adequate head to bring the fluids down to the spigots over the sink. As these cans are made for filling easily from open buckets, replenishing the solvent can be done easily by stepping on the laboratory bench and pouring the fluid directly into either can by using a common funnel. This method of bringing solvent through spigots to the sink is much easier than pouring a small quantity from a large container on the floor each time equipment must be cleaned thoroughly.

Solvent Container Arrangement.

HOW TO—

Make Bracket For Oil Drum

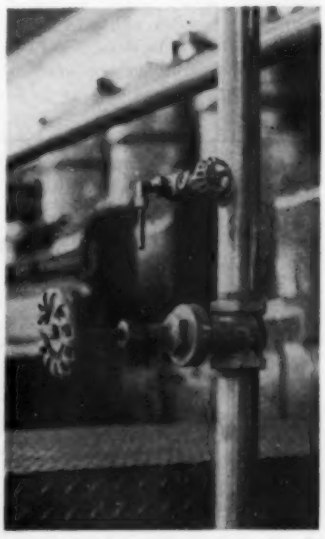
WHEN pumps, or engines are operated at some distance from the main equipment, a supply of lubricating oil is provided in the original drum which is mounted on a bracket welded to the low rail around the machinery. At one plant the rail is made of six-inch line pipe supported on short posts of similar material. The bracket is made by cutting odd pieces of tread stock as saddles into which the drum will fit securely. One piece is welded directly to the top of the six-inch pipe rail. The other to a diagonal nipple of four-inch pipe which, in turn, is welded near the base of the railing post. Two pieces of smaller pipe are welded at one end, to the rail and at the other to the saddle-shaped piece of tread stock which supports the oil drum. The distance between the two saddles is slightly less than the length of a standard oil drum, so the chimes will overhang, but of a length so the drum can be set into the saddles conveniently. The saddle attached to the diagonal brace is built approximately two inches lower than the one fixed to the rail so practically all of the oil can be removed from the drum without tilting.

HOW TO—

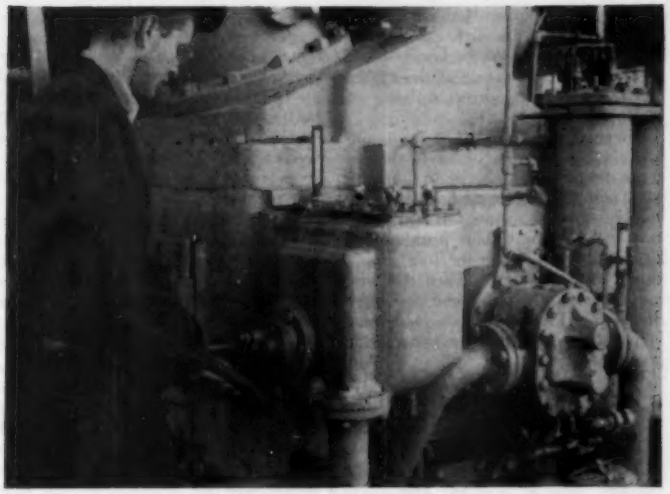
Install a Gasket Leak Try-cock

A SUSPECTED break in the cylinder head gasket of a high-pressure condenser may be determined quickly when a try-cock is set into the jacket water discharge line. If the head gasket is not properly installed, leakage pressures ranging to high levels can cause gas to channel through an infinitesimal break in the structure of the material. Gas will travel into the jacket water and pass out to the coolers.

The try-cock is used to determine whether or not leaks occur. It is placed in the vertical pipe line at a convenient height. Upon opening this cock, gas contained in the jacket water will cause a series of breaks to occur in the flow of water. If no leaks are present, the stream of water will be steady and unbroken.



Gasket Leak Trycock.



Operator uses an air-motor to pump oil through the engine distribution lines before starting.

HOW TO DO IT—

Notes on Starting and Maintaining Gas Engines

JOHN C. ALBRIGHT, Santa Monica, Calif.

STARTING gas engine driven compressors—angle, horizontal, or V-type—requires that the operator give attentive observance to the fundamental rules common to the procedure for starting internal combustion engines in gasoline plants, refinery vapor recovery units, or other refining units Start-up of an engine is a procedure consisting of related operations performed in sequence, so that the start-up is done smoothly, easily and without loss of time. The start-up procedure should be followed regularly without deviation to avoid forgetting or overlooking an important step, the result of which might be disastrous.

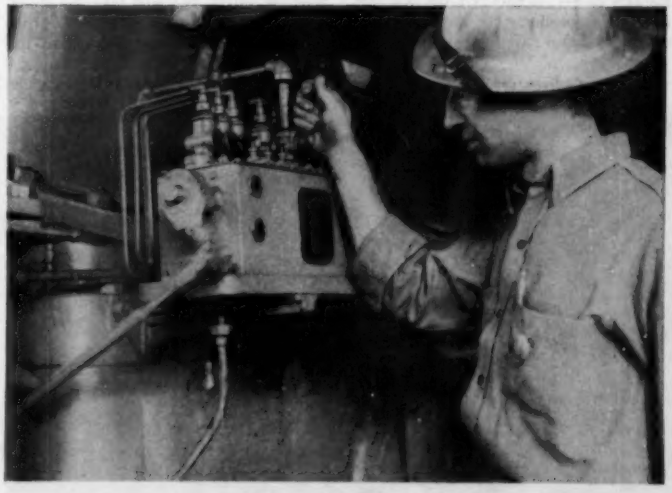
To the experienced operator, it matters little whether the engine room assigned to him contains horizontal or other types of engines, because each type requires fuel, ignition, cooling water, and lubrication. However, to the operator or engineer taking over the job of running a string of unfamiliar engines, it is by no means a waste of time for him to study thoroughly all the available literature relating to that particular make and model engine.

With a wealth of experience, Jack Magruder, top gas engine man and trouble-shooter for Richfield Oil Corporation, discusses some of his experiences with engine troubles and their solution. According to Magruder, the seven 600-horsepower compressors in the catalytic cracking compressor house at the 100,000-barrel-per-day refinery at Watson, Calif., have been operating some five years. Their condition reflects the attention they have received from operation and maintenance by machinists and mechanics, who have become familiar with gas engine operation, repair and maintenance through years of experience. During the five-year period of operation, no difficulty has been experienced with main bearings of the engines, and only three connecting rod bearings have required replacing.

Engine Troubles and Solutions

When an engine is not receiving the correct volume of fuel, there are several checks that should be made by an operator. The valve in the fuel line may be partly closed, or clogged. It should be cleaned and set at the run-

Operator fills a Torrington sight feed lubricator by opening a valve to let oil through lines from outside tank.



ning position. If the mixing valve is stuck, or its action is sluggish, it will not respond quickly enough to the engine fuel requirements to maintain the desired running speed. When the barrel of the valve is rough or sticky, due to gum or dried oily residue, the surface should be cleaned and polished with a mild abrasive compound, wiped clean again, and reassembled. The low-pressure, supersenitive fuel valve should be checked to see that it is not sticking or out of order. The valve should be cleaned thoroughly. A new diaphragm should be installed if the one in use is porous, frayed or has lost its resiliency. Then the valve should be reset to deliver fuel at the required pressure. The regulator diaphragm cover should be checked to see that the vent is open and that the vent pipe is not plugged.

Troubles may lie in the main gas valve, due to sticking or other causes. Usually, two pressure regulators are installed to operate in series so that the first valve will reduce the pressure from the fuel gas line to about 15 psig, and the second regulator reduces it to about 16 ounces. The gas then flows into the fuel regulating valve of the engine. All three regulators must be kept in top operation condition to supply the required amount of fuel.

The principal cause of uneven operation accompanied by knocking, and spark plug fouling is due to the fuel gas pressure being too high. When fuel gas pressure is too low, the engine must "reach out" further than normal to get its fuel. Under this condition the engine rpm may vary considerably from fast to slow, which results in loss of power. Both conditions, high or low fuel pressure, can be remedied by checking the fuel valves and regulators as in the case of the engine not receiving the correct volume of fuel.

An engine running on a fuel mixture that is too rich or too lean will cause the exhaust valves to burn or stick and the engine to backfire. Obviously, this condition causes the engine to lose power. This problem can be solved by checking the fuel supply valves and regulators. Then the mixing valve should be "tuned up" until the engine takes over the load, provided other parts and functions are in good condition.

Checking the Spark

If the engine is not receiving the correct spark at the plug, there are a number of items that should be checked, one at a time. The spark plugs should be checked first. Plugs with broken insulators should be replaced. The points of the plug tend to widen under operating conditions and should be checked with a feeler gauge so that the gap will be correct. If the points are fouled with carbon deposits, they should be carefully cleaned and reset. In some instances, moisture may be on the plugs due to improperly dried starting air. Spark plug wires may be water soaked due to a leaking gasket on the water jacket, or a leaking head gasket.

The operator should check the operation of the magneto, connections to the distributor, magneto, and spark plugs. The magneto should be checked for timing and condenser leakage. The segments on the distributor should be checked to determine if they are burned until the spacing is so wide that the safety gap will take the spark instead of allowing it to follow through the secondary wiring to the spark plugs. The breaker points in the magneto could be out of adjustment, too wide or too close to generate a hot spark. Occasionally, the breaker points are pitted or projections have been built up on them, which results in an inaccurate gap adjustment with the feeler gauge. If one of the safety instruments, for example, the temperature controller, is out of order, it may cause the magneto to short out on a temperature lower than the normal operating temperature. An overspeed switch out of adjustment may cause the magneto to short out at a speed lower than the operating rpm.

Low power cylinder compression is caused by sticking valves due to gum or dirt in the valve guide, or a broken or weak spring. Also the piston ring may be too wide for the groove and stick in one position, which allows the gases being compressed to blow by the piston into the crankcase. This ring should be replaced or freed to prevent scoring, grooving, or uneven wearing of the cylinder walls.

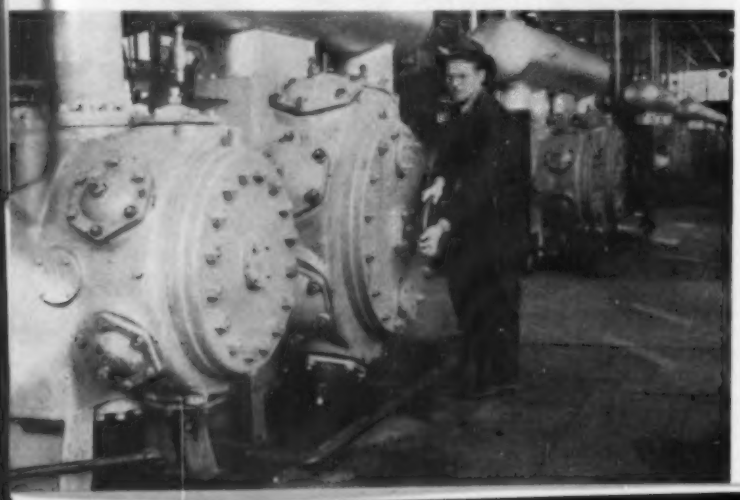
When it appears that an engine becomes overloaded easily and heats up too quickly, the difficulty may be caused by the use of an inferior grade of lubricating oil, which does not maintain a film of oil to cushion the shock and reduce the friction of moving parts. Also, the engine may not be timed correctly, or water circulation through the jackets may not be sufficient to maintain the normal operating temperature. Occasionally, there may be some obstruction in the water jacket preventing circulation, or it may be airbound. In addition, if a valve in one of the compressor cylinders is broken or not seating properly, the entire engine may overload to a point that will cause overheating.

Overheated Crankshaft Bearings

Crankshaft bearings that overheat may be too tight, or too many shims may have been inserted between the bearing caps so that the bearing is loose. On the other hand, the lubricating lines and distribution piping may be plugged, or the oil pump may not be operating properly. If the oil level indicator gives a false reading of the oil level in the crankcase, the level may not be high enough to be picked up by the oil pump. Sometimes small particles of dirt, scale, or bearing metal, not removed by the oil screen, will lodge in the bearings and cause it to overheat.

When the starter check valve is not seating properly, the hot gas from the combustion chamber will creep back into the air supply system, and the starting air lines will get hot.

Operator adjusts compression to handle varying load on the low cylinder at Richfield.



If the engine misses frequently or consistently and dies easily when the load is applied, the spark plugs should be checked and adjusted or replaced if necessary. The cylinder head bolts may not be tight, or a flattened gasket is leaking water into the cylinder to prevent the plug from firing properly. The cylinder will miss if one of the valves is warped or burned.

A hard-to-start engine may be due to the wiring of the electrical system being soaked with oil or water, causing a short circuit. Also, spark plug wires may have been crossed, or the fuel mixing valve may be loose, providing a poor mixture of air and fuel.

If the fuel scrubbers were not serviced recently, distillate or condensate may be fouling the lines or fittings. When the starting air compressor is run on rainy days or during damp weather, the water in the air tanks may be carried into the cylinders to prevent the plugs from firing. The governor and air starting valve should also be checked. Insufficient air pressure will not turn the engine over.

Routine Suggested

Some engine rooms are serviced exclusively by the mechanics and machinists. Others are serviced by the company mechanical department. In some cases, the company employes combination operators and repairmen to operate and repair the engines. When the engine room engineers, operators, or oilers are required to change spark plugs, adjust the various parts, and perhaps replace magnetos, valves, etc., they should be responsible for starting, adjusting and placing the engine on full load. Thus a certain routine should be established and a consistency of method followed that will always insure satisfactory starting.

As an example, when an engineer comes on tour and an engine is down that is not ready to go back on stream, the engine room log book should show what has been done to the engine and its condition at that particular time. The engineer just coming on tour should determine the exact status of the engine. If the engine is ready to be placed in operation, but has not received a final check, the operator should bar the engine over at least a full revolution. By jacking the engine over not less than a full turn, he can determine if there is anything loose in the cylinders or the crankcase. Jacking the engine over will not damage the parts, but if it is jacked to the starting marks, the starting air turned in, the action of the engine is the same as if it were on a firing stroke and serious damage may result if any loose parts were left in the cylinders.

When the engine is ready to run, the operator checks to see if the discharge gate valves are closed, the low-pressure cylinder gate valve is opened, and the by-passes on each cylinder opened. The cooling water is turned on to see that the circulation is obtained and that the water coming to the jackets is hot enough. Many engines are being operated with only a 10 or 15° rise between inlet and outlet cooling water. The low, or inlet temperature is about 140° F. and the outlet temperature about 150° F. The water should be circulated for approximately a half-hour, so that all parts of the engine can warm up and expand evenly.

During the time the water is circulating, the operator should check the gaskets on the heads, side plates, and valves. Fuel pressure should be checked, regulators inspected, and the oil level in the base checked. Spark plug wires should be traced to see that none are crossed at the breaker distributor or plugs.

Some types of engines are provided with an auxiliary oil pump that can be operated manually, electrically, or air motor, to pump all the oil lines and distributing pipes full of oil to feed moving parts in the same manner as the regular oil pumps. The lubricator on the side, or on the bed-plate is given several turns with the crank to see that all pumps are working and that the oil is being pumped to the points where lubrication is necessary.

When ready to start the flywheel is barred over to the starting point. Then the idle latch for the throttle or governor control is set to hold the linkage to the point when the engine will turn over slowly without a load. The air tanks are blown down to eliminate any water that may be pulled into the cylinders.

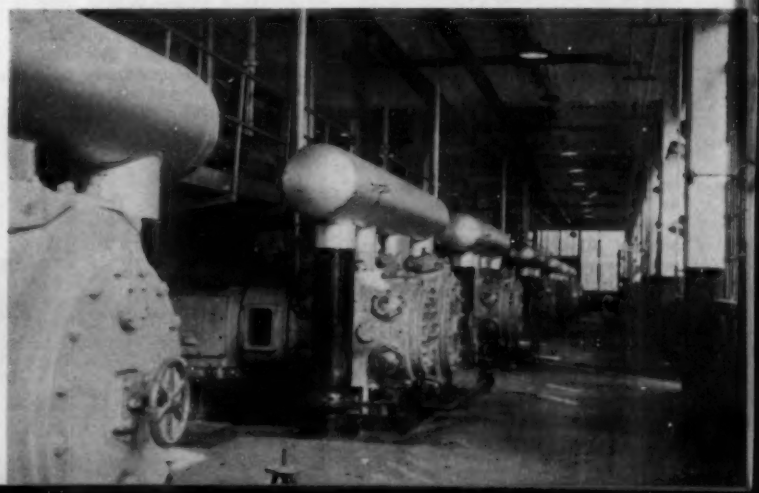
Then the safety switches are opened and the ignition switch closed so the magneto will deliver spark to the plugs. The air line bleeder valve is opened to purge the cylinders of any residue gas. Then the starting air gate valve is fully opened to take advantage of the full power of the tank pressure.

After the engine has turned over several times the gas supply valve is gradually opened to permit a small volume of gas to enter the cylinders. Permitting the air to flow into the engine without the fuel gas for several turns of the engine, generally will prevent explosion of gas in the exhaust muffler. When the engine begins to fire, the starting air is turned off and the engine run at slow speed for a few minutes.

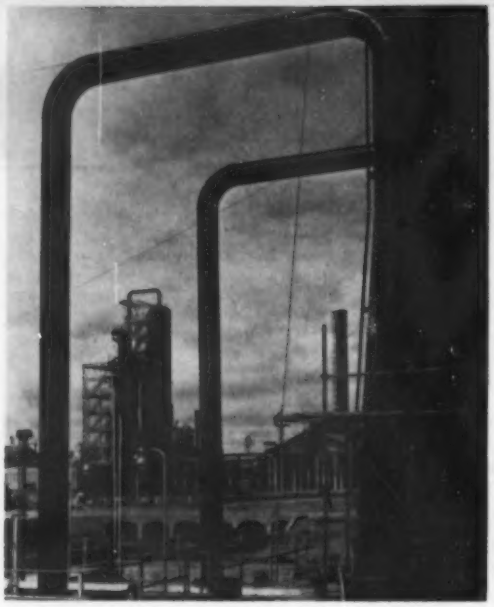
After the engine has been running for a few minutes, the speed is slowly increased until it reaches the normal operating speed, which is controlled by the governor. Then the by-pass valve on the high pressure cylinder is closed slowly until pressure is about half the running pressure. The discharge gate valve is then opened so that the high pressure cylinder is at the running pressure, but not compressing the gas because the low pressure cylinder is running on an open by-pass line.

The low-pressure cylinder by-pass valve is slowly closed so that the engine is loaded gradually. The operator then should make final adjustments to the throttle and mixing valves and double check the water temperature, oil pressure, and lubricator sight feeds.

Compressor end of the 7 KVGs in Richfield Oil Corporation's Watson, Calif., plant pictured here.



Grangemouth Refinery Continues Two-Stage Expansion



Atmospheric Distillation Unit from Blow-Down Stack at Grangemouth.

EARLY in March the new crude distillation unit at the Grangemouth Refinery in Scotland, owned and operated by Scottish Oils Ltd., a subsidiary of the Anglo-Iranian Oil Company, went on stream. The original refinery commenced operations in 1924. The first substantial enlargement program was launched in 1929.

The postwar expansion of the refinery is being undertaken in two stages. The first stage, including the installation of a modern pipestill distillation unit, with gas stabilizing equipment and a comprehensive range of treating plants for refining various fractions, was completed last spring. Forming an integral part of this phase is the new plant of British Petroleum Chemicals Ltd., a joint Anglo-Iranian and Distillers venture to turn out a wide range of chemicals from a feed stock provided by the enlarged refinery. It is already producing ethyl and isopropyl alcohol. A new steam boiler and a power plant of 20,000 kw. have, too, been completed. These, with water pumping, cooling and compressed air facilities, are situated in a service area lying between the refinery and the petrochemicals plant.

Work is in progress on stage two, scheduled for completion by the middle of 1952. It provides for the manufacture of premium grade spirits and special products. It embraces one of the most modern Fluid catalytic cracking units, with a vacuum distillation plant to furnish the feed stock, and a catalytic polymerization unit to yield a stable spirit from exhaust gases. In addition, there will be a treating plant to handle products from the cat cracker and small distillation and treating capacity for white spirit and other specialty items.

Two new jetties, extra storage tanks, dispatching lines and pumps and additional road and railroad filling sheds form other integral parts of the second stage of the expansion program. A new office and laboratory are under construction. Additional houses are being built to house the augmented staff required by the refinery and chemical establishments.

In addition to the reconstruction and enlargement of the refinery, Anglo-Iranian recently laid a crude oil pipe line across the country and is erecting in conjunction with Monsanto Chemicals another major plant for the production of petrochemicals, particularly monomeric styrene. When the Finnart-Grangemouth pipe line came into operation last April the refinery's capacity went up to 13,179,600 barrels a year, or treble the figure for 1950. Before the war the refinery's annual thruput capacity was only 2,635,920 barrels.

The original refinery (of 1924) was designed for the manufacture of a limited range of products—gasoline, kerosine and fuel oil. The equipment, the simplest, comprised a battery of five shell stills, a steam-heated shell still redistillation unit for the separation of kerosine from gasoline, paddle-agitated washers for refining gasoline and a bauxite plant for the final sweetening of kerosine. Auxiliary equipment consisted of steam boilers with pass-out turbines, pump-houses, workshops, offices, etc. A single jetty within the Grangemouth dock area handled inward and outward shipments.

In 1929 two continuous crackers with stabilizing equipment, an Edelaneau SO_2 plant, a Holly Mott washery and ethyl blending equipment were installed, and additions made to the power plant, workshops, jetties, etc. The range of products turned out included premium and commercial grade gasoline, two qualities of kerosine, tractor vaporizing oil, white spirit, rubber solvent, gas oil and several grades of fuel oil.

Early in 1940, lacking crude oil supplies to feed it, the refinery was shut down and placed on a care-and-maintenance basis. Immediately after the war market demand was for quantity. Therefore the cracking units were converted for the distillation of crude oil, and other equipment adapted to give the maximum yield. By such means thruput was raised to 4,905,740 barrels yearly.

Tank Farm with Catalytic Cracker Construction in Left Foreground, Grangemouth, Scotland.

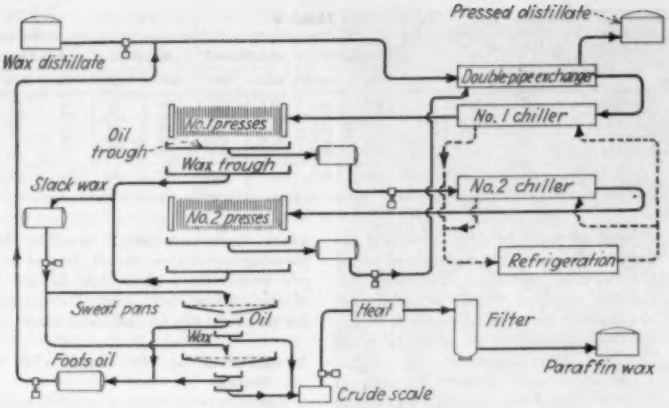


Figure 1. Diagram of the Operations of Double Pressing and Sweating.

NOTES ON DEWAXING

Plant Capacities and Yields Set by Operating Techniques

PART I

PAUL ZURCHER
Associate Professor, University of Tulsa, Tulsa

IN dewaxing by pressing and by centrifuging, the main requisite is the control of the shape of the wax crystals. The paraffin wax contained in the lighter lubricating oil fractions crystallizes on chilling in the form of needles and hexagonal plates and can be separated from the oil in filter presses. In the heavier cuts, it precipitates in the form of fine needles. Removal of this type of wax, called petrolatum, is accomplished by centrifuging.

Wax distillate consists of the so-called neutral oil fraction, a considerable amount of gas oil as diluent, and paraffin wax. Its boiling range, not considering purposely added naphtha may be between 250 and 650° F. at 40 mm. absolute pressure, and viscosity may vary from below 60 to above 100 S.U. at 100° F.

For removal of the wax, the oil is chilled, and the solid wax is separated in filter presses. The resulting wax cake, called slack wax, is freed of its oil content in the sweating operation.

In a typical operation, Figure 1, wax distillate is forced under pressure through double pipe chillers in which it is cooled in successive steps with cold water, dewaxed oil from the filter presses, and brine or expanded ammonia. The resulting oil-wax slurry passes into filter presses where the liquid phase flows through canvas filter blankets and is collected in a trough under the press. The filter blankets are mounted on steel plates, usually four feet in diameter. As many as 500 plates are assembled in a unit, Figure 2. The wax remains trapped between the blankets as cakes which are usually one half inch thick. When the presses are completely filled with wax as indicated by the cessation of the flow of oil from the presses, the filter plates are pulled apart, and the "slack wax" cakes are pushed off with paddles called "spudders." A conveyor carries the broken cakes to a tank where they are melted.

THE DEWAXING of oils by chilling and pressing or centrifuging has long been the "conventional" method for processing lubricating oils and continues in wide use even though there a number of more "modern" solvent refining methods for dewaxing. In cases where the quality of the original stock is high and the capacity of the plant small, it is often difficult to justify the installation of the more expensive solvent refining methods. This article reports many of the operating details of the pressing process.

For the purpose of producing neutral oil of different pour points, dewaxing can be carried out in two steps. The wax distillate is first pressed at 35-40° F., yielding an oil of 20-30 pour point. In the second step, the oil (hot pressed oil) may be chilled to —10° F. for the production of a zero pour point oil (cold pressed oil). Today, pour point depressants attain similar results with less touble.

Oil present in the slack wax is removed in the sweating operation on the sweat pans. These are shallow containers, 10-20 feet in width and up to 60 feet in length, with side walls about eight inches high. A number of these pans are stacked with sufficient space between them for the access of the repair man. In the pans, the molten slack wax coming from the presses is solidified by atmospheric cooling and by circulating water in a set of closely spaced chilling pipes submerged in the body of the wax. The solid mass is heated at the rate of 2-3° F. an hour by water of automatically controlled temperature passing through the pipes inside the wax cake. A mixture of oil and low melting point wax begins to drip from the cake and is collected as "foots oil" until the temperature of the pans is in the vicinity of 100° F. Foots oil may be resweated for the production of low melting point wax or is used as cracking stock. An intermediate fraction of drainings is gathered while sweating continues until the temperature of the desired melting point of the wax is reached. This intermediate fraction is mixed with a fresh charge of slack wax and returns to the sweat pans.

The wax remaining on the pans (crude scale) is melted, treated with acid and filtered through fuller's earth at about 25° F. above its melting point. Acid treating is not required if a product of good color and low oil and moisture content can be made. The most common specifications for commercial waxes are color, melting points 122-

124 and 132-134° F., and maximum oil content below 0.5 per cent.

Wax Pressing and Sweating

Many puzzling deviations from normal production may occur in the wax pressing and sweating operations. One day, the press cake may be dry, drop easily from the blankets and sweat perfectly. The following day, the slack wax cake may be wet with oil, must be scraped off, and will yield no scale wax. Careful investigation of all the factors influencing wax production will clear up many problems. This is a difficult task in a plant where the crude oil supply is frequently changed, and, as is usually the case, the wax plant must yield first place to the neutral oil production.

The main causes of troubles in the wax plant are:

1) Frequent change in crude oil supply
2) Stratification of the crude oil in storage
3) Time elapsed between distillation and dewaxing (in certain cases)
4) Fluctuations in still operation, affecting distillation range viscosity, and resin content of the wax distillate
5) Defective equipment
6) Lack of supervision
7) Atmospheric conditions

Source of Crude Oil—Different crude oils yield varying percentages of wax distillate if a fixed viscosity is prescribed. Boiling ranges and wax contents are not the same. The shape and size of the wax crystals which are typical of a crude, may adversely influence the ease of pressing and hence the sweating operation. Two wax distillates obtained from two different crudes may have to be pressed at different temperatures in order to yield the same pour point; a drop of 10° F. at the presses reduces throughput a great deal. Following is an example of two wax distillates from different crude oils which were adjusted to produce identical yields of neutral oil. As a consequence, their end points are different, and the scale wax yields are not the same. See Table 1.

TABLE 1

	Oil A	Oil B
Yield of specified neutral oil, percent	30.95	31.07
Scale wax yield based on wax distillate, percent	4.26	4.45
90 percent boiling point (40 mm. abs.) of wax distillate	591	588
End point (40 mm. abs.) of wax distillate	629	613

If the end point of the wax distillate B (613° F.) had been increased to that of oil A (629° F.), its neutral oil and wax yield would have been higher. On account of the unfavorable shape and size of the wax crystals which were very small needles, the pressing operation of oil B was ten per cent slower than that of oil A of the higher end point. The reason for this behavior is discussed later.

TABLE 3

	Vis. at 210°		Wax Percent		Wax M. P.		Pour Point	
	Feb.	Sept.	Feb.	Sept.	Feb.	Sept.	Feb.	Sept.
Top	58.6	64.0	14.5	18.1	128	127	76	87
Down ¼	59.0	57.6	15.1	15.6	125	127	76	72
Down ½	62.0	58.9	16.6	14.8	129	126	78	76
Down ¾	63.6	58.9	17.6	15.3	128	124	85	82
Bottom	57.6	59.6	13.3	13.8	126	127	81	78
Average	60.1	59.8	15.5	15.5	127	127	79	79

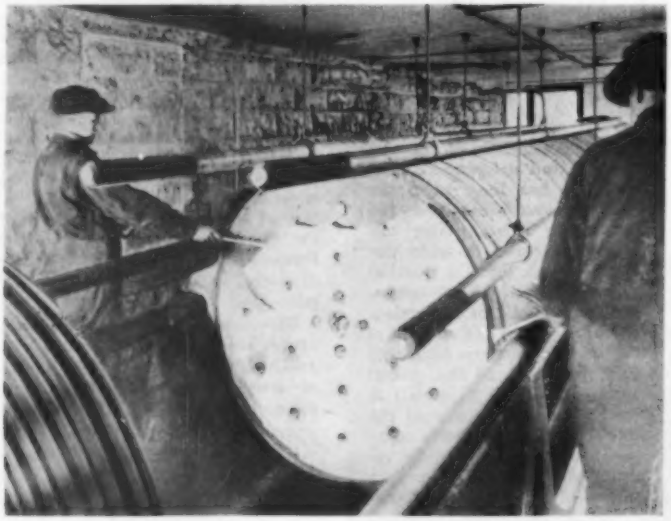
Stratification of the Crude Oil in Storage

Viscosity, wax content, melting point of the wax, as well as the pour point of the oil charged to the still from the same crude oil tank, may quickly change to such a degree that a smooth dewaxing operation is impossible. In tracing these fluctuations, samples were taken at different levels of five crude oil tanks which had been filled three years previously. When reduced to the same percentage of bottoms, the samples had viscosities as shown in Table 2.

TABLE 2

At 210° F. Tank No.	I	II	III	IV	V
Top	45.4	35.7	48.8	47.4	45.9
Down ¼	48.6	48.4	49.4	49.0	48.0
Down ½	48.6	47.2	50.4	47.2	48.0
Down ¾	48.0	48.9	47.7	44.4	47.6
Bottom	46.5	44.5	48.2	46.4	47.6
Average	47.1	44.9	48.9	46.7	47.4

Figure 2. Spudding a Wax Press (Carbondale Machine Company).



Stratification in crude tanks changes with the seasons because of heat convection currents. Samples were taken from a crude tank in February and in September of the same year. When reduced to the same percentage of bottoms, viscosities, percent wax content, melting points of the wax, and pour points of the samples from the different tank levels were as shown in Table 3.

In the seven months, the highest viscosity moved from three-fourths down to the top; the highest wax content from three-fourths down to the top; the highest melting point of the wax from one-half down to the top; one-fourth down and bottom; the highest pour point from three-fourths down, to the top. These fluctuations might be eliminated by warming and circulating the oil in the crude tanks before moving it to the still.

It may happen that a wax distillate which has been stored for some time will cause much difficulty in pressing and sweating. For instance, excess wax distillate production from the still was

run into a separate tank and held as an emergency supply. Material from this tank would reduce the charge to the presses by 12.5 percent, and the oil content of the slack wax was as high as 50 percent. A slimy deposit gradually clogged the filter blankets. The wax crystals were intertwined strings and knotty needles, and the wax cake was brown. On the sweat pans the charge suddenly liquefied at a certain temperature, only a black scum was left on the supporting screens. Examination of the stored distillate disclosed that its color changed in two weeks from light yellow to a dull brown with no visible precipitate. A brown sediment was found at the bottom of the tank. The wax in the oil at the top began to crystallize at 62° F. and that near the bottom at 77° F. Size and shape of the wax crystals were different at the two levels. Dewaxing of this oil was improved in proportion to the amounts of fresh distillate added. It was concluded that stratification of the wax and polymerization of resinous matter in distillates of high end point were the causes of the disturbance. Proof was that oils that did not darken more than one half point in ASTM color in three days caused no trouble. The difficulty was overcome by passing all the wax distillate from the still through this tank, thereby assuring a more even charge to the presses. Distillates which had been stored in other tanks for almost a year were found to be of good pressing quality. Some of them originated from different crudes and had lower end points than the distillate in the emergency tank. Contamination with resinous matter was unlikely.

Addition of a polymerization inhibitor may be a safe preventive against the darkening of stored oils, provided it does not adversely influence the crystallization of the wax.

Fluctuation in Still Operation—Viscosity, distillation range, and resin content of the wax distillate are of the utmost importance for good pressing and sweating operation. Viscosity, however, is not significant, if it is not fixed by the distillation range. An oil containing very low boiling initial fractions may have a low viscosity, but may yield more scale wax than an oil of higher initial boiling point and the same end point. With distillates from the same crude oil, the charge to the presses dropped ten percent as the initial boiling point rose from 348 to 380° F. (40 mm. abs.), and the s.u. viscosity increased from 66.1 to 69.7 at 100° F. as a consequence of the higher boiling point, the end point fluctuating only 3° F. around the average. Scale wax yield in percent of slack wax decreased from 30.6 to 26.9 percent. See Table 4.

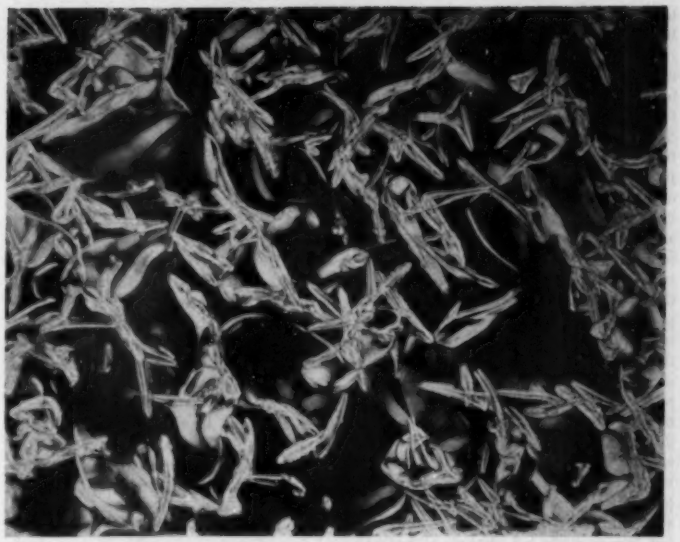


Figure 3. Conversion of Plates into Needles in Different Stages of Progress.

TABLE 4

IBP (40 mm.)	5 Percent	Flash	Vis. 100	Scale Wax Yield Percent of Slack
348	387	293	66.1	30.6
352	388	293	67.9	30.6
381	412	304	69.2	26.9
380	413	309	69.7	27.5

Good scale wax yields may be expected from distillates of low viscosity caused by low IBP, if the 90 percent (and the end point) is increased up to a certain limit as is seen in the Table 5 example.

TABLE 5

Viscosity at 100	90 Percent Distilled	Daily Wax Percent of Maximum
65.8	585	58
66.8	596	84
67.1	596	92
67.1	599	100

Regarding other points on the distillation curve, a comparison of many runs disclosed the following. The 50 percent, 90 percent, and end points are of great importance for good operation, and the end point should be held as high as possible under best conditions of fractionation, because the crystal form of the wax of the higher boiling fractions is conducive to high press charges and low oil content of the slack wax. This is apparent in Table 6.

A general trend in increase of viscosity, the three boiling points, and scale wax yield is unmistakable. If a maximum of wax is to be made, the most favorable distillation range must be found by trial and error. Too high a viscosity caused by lack of dilution by low-boiling fractions will reduce throughput through the presses. The upper limit of the end point is where the presence of a considerable amount of resinous matter begins to interfere with the operation. An asphalt content of more than 0.3 percent may greatly reduce the yield of scale wax.

TABLE 6
Relation of Viscosity and Distillation Range (40 mm. abs.) to Scale Wax Yield.

Viscosity at 100° F.	50 Percent	90 Percent	E.P.	Scale Wax Percent of Slack Wax
66.0	497	584	622	17.0
66.6	...	586	621	19.8
69.0	502	588	627	23.9
68.4	501	590	626	25.6
67.7	504	596	625	26.9
68.1	505	590	625	26.9
69.8	505	594	630	29.5

The importance of holding the distillation range and the corresponding viscosity within narrow limits can be judged from a test of several months duration. When viscosity and boiling range were within the prescribed limits found to be best during 50 percent of the time, the sweat yield was 15 percent of the slack wax. As the operation improved, scale wax yield increased steadily until it was 25 percent of the charge when the wax distillate was 100 percent within the set limits.

Oil Content of Slack Wax—The crystal form of the wax is the main factor influencing scale wax produc-

tion directly. Several opinions have been expressed by authorities regarding the formation of the different crystals. Some ascribe the needle form to higher-melting point waxes which freeze out first on chilling and give dry slack wax cakes. Others believe that isomeric forms of the wax crystallize in needles while normal paraffins are hexagonal plates. Still others are convinced that surface tension plays a major part and may convert plates into needles. The latter opinion is sustained by the observation under the microscope of sudden change of plates into needles by a jerk-like rolling up of the plates. Figure 3 shows the conversion of plates into needles in different stages of progress. All experts agree that the presence of certain materials in the distillate, e.g., flux, needle wax, in the cold pressing charge, influences the crystal form and hence the oil content of the slack wax on which depends the yield in the sweat house. Additions to the distillate for the purpose of changing the wax crystal type are common in solvent dewaxing.

The fact is that in double pressing, first at say 40° F. (hot pressing), for removal of a part of the wax, then at a lower temperature for elimination of the balance, the wax cakes of the two pressings are different. Hot pressed slack wax consists of needles, and cold pressed wax of plates. Usually, the former contains much less oil than the latter and yields more scale wax on sweating. Upon adding to the hot pressed oil as little as three percent of the intermediate fraction from the sweating of hot pressed slack wax, the oil content of the cold pressed slack wax is reduced, and the scale wax yield is increased. For instance, this step lowered the oil content of a cold slack wax from 50 to 37 percent and raised the scale wax yield from 22 to 30 percent. Figure 4 shows photomicrographs of hot slack wax, cold slack wax, hot sweat intermediate wax and scale wax. Attention is called to the dark lines along the longitudinal axis of the needles, which may be a proof of rolled-up hexagonal crystals.

The scale wax yield is reciprocal of the oil content of the slack wax. In Table 7 are recorded the oil content of the cold pressed slack wax, the scale wax yield in percent of the charge to the sweaters, and the percent of maximum scale wax produced.

TABLE 7

	Oil in Slack Wax Percent	Scale Wax Percent of Slack Wax	Daily Scale Wax Percent of Maximum
1	43.7	16.9	80.4
2	43.3	16.9	67.1
3	41.2	20.5	78.0
4	36.9	24.2	86.8
5	38.6	22.9	86.8
6	38.5	21.1	75.4
7	36.5	24.4	75.6
8	33.3	29.3	100.0

In Example 4 the sharp drop in oil content of the slack wax and the increase in scale wax yield were the result of the replacement of broken filter blankets and twisted press plates. The change to worse in line 5 was caused by the blending of inferior stored distillate with fresh stock. Best wax yields were obtained in Example 8, when the hot pressed oil had been inoculated with 3 percent hot sweat intermediate before cold pressing.

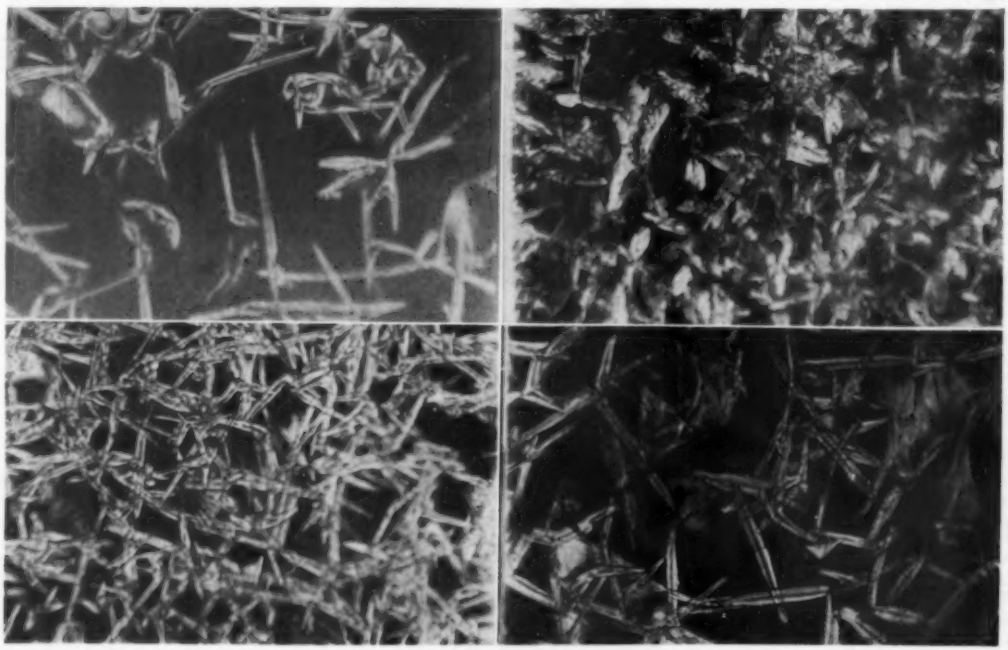
Figure 5 represents in graphic form the daily oil content of slack wax and the corresponding scale wax yield during one month's operation.

The dry wax content in the slack wax is approximately the same regardless of the oil content when calculated as percent of the wax distillate charged to the presses, as shown by analyses shown in Table 8.

TABLE 8

Slack Wax Percent of Distillate	Oil in Slack Wax Percent	Slack Wax per 100 Parts Distillate	
		Oil	Dry Wax
16	30	4.8	11.2
17	34	5.8	11.2
18	35.4	6.4	11.6

Figure 4. Crystal Forms of Waxes. Top left: Hot Slack Wax. Top right: "Cold" Slack Wax. Bottom left: Intermediate. Bottom right: Scale Wax.



Blankets—Claims that copperized blankets were superior to white blankets were checked by operating one press with white blankets and another with green blankets for 30 days. During this period, the oil content of hot pressed wax from the white blankets was 40.4 percent, and the scale wax yield from the slack amounted to 20.8 percent. The slack wax from the green blankets contained 28 percent oil and yielded 44.5 percent scale wax. No inferior slack wax was produced in the press with the green blankets, despite considerable fluctuations in the quality of the wax distillate. When all the presses were gradually provided with green blankets, the average charge to the presses increased 15 percent, the scale wax production 30 percent, and the yield of neutral oil almost 20 percent. As time went on, the effect of the green blankets became erratic, it being blurred by changing other factors. It can be said for certain that the installation of green blankets will shorten the press cycle, principally because they remain in good condition longer than white blankets. Upon reducing the press cycle by 8 1/3 percent, no change in yield of the individual presses was noticed, but the calculated increase in production of 8 1/3 percent was not reached. Actually it was 4.4 percent.

Temperature of Pressing—The viscosity of the charge to the presses increases very rapidly with decreasing temperature. As a consequence, throughput varies with the desired pour point of the neutral oil. Taking the throughput in double pressing at 40° F. and at 10° F. for making 10 pour neutral oil as 100, the charge to the presses dropped 16.9 percent when zero pour neutral oil was made, and increased 35 percent above normal for the production of 30 pour point oil in single pressing.

Maintenance and Supervision—Watchfulness on the part of the foreman may increase scale wax production. For instance, if the troughs located under the presses that carry off the dewaxed oil are not emptied before the wax is dropped into them, the oil content of the slack wax is increased and the scale wax yield decreased. Perforated blankets and twisted filter plates let pass wax with the oil, and the pour point of the neutral oil rises. The wax cake on perforated blankets will be wet because sufficient pressure cannot be built up to dry it.

When a number of presses are working in parallel, maintenance of even operation is impossible. The moment an empty unit goes on stream, the over-all pressure drops from about 300 psig. to about 20 psig., then rises gradually as the flow of the slurry of oil and wax to the new press is slowed down by the resistance of the wax cake being built up. In the mean while, all the other presses in different stages of completion of the cycle are marking time. The best remedy would be to fill an empty press by means of a separate pump and then to expose its content to the normal pressure of the whole system.

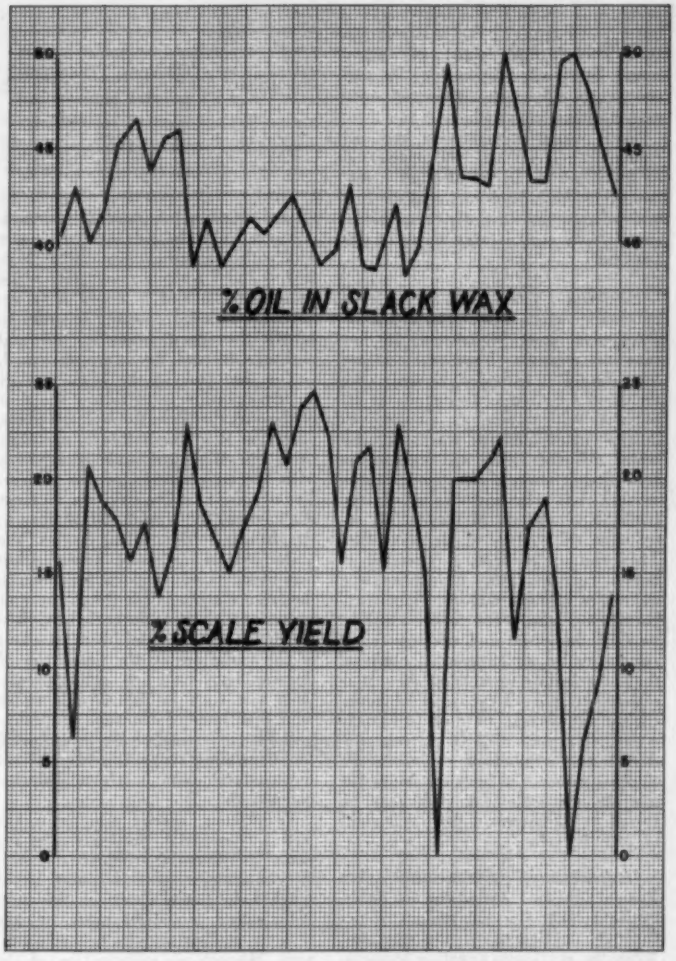


Figure 5. Relation of Oil in Slack Wax to Scale Wax Yield.

Wax Sweating

Slack wax contains from less than 30 percent to as much as 60 percent oil sealed in between the wax crystals. Usually, an oil content of up to 40 percent assures good scale wax yields, while a cake with 50 percent or more oil may produce no scale wax.

Soon after sweating has begun, the success or failure of the operation can be predicted. When the oil has drained from the top layer of the wax cake on the pan and a coherent skin can be lifted from the surface without breaking, the wax will sweat well. A further test is to squeeze a lump of wax in the hand. A good scale wax yield can be expected if the oil flows from between the fingers, and a solid, white lump of wax is left in the palm. When torn apart, the wax shows a fibrous structure. A slack wax of glassy appearance on the pan forms no surface skin and will disintegrate and flow from between the fingers when squeezed, leaving nothing in the hand. Such a sweat charge may suddenly collapse, flow off when a certain tem-

perature is reached, and leave nothing but a black scum on the screen of the pan. These simple tests save many hours of useless operation. A bad charge should be run down at once as promising no yield.

Slack waxes of relatively high oil content can frequently not be sweated to specifications in the allotted sweating cycle. Melting points may be low and oil and moisture above specifications. Such scale waxes must be resweated.

Sweating Cycle—A fixed cycle is necessary when large quantities of slack wax must be treated. In hot summer weather, however, chilling time should be extended, or scale wax yields will be reduced as much as 10 percent. With inadequate chilling facilities, insufficient or warm cooling water, all the slack wax cannot be solidified at atmospheric temperatures around 100° F. and higher. Large pools of a solution of wax in oil remain on the surface of the wax cake. They run off as soon as sweating is begun, carrying away considerable quantities of high melting point wax. Sacrificing some time to the chilling part of the cycle and making fewer runs may be advantageous. Suppose that in a certain number of days it is ordered to run 30 cycles at 23 hours each at an average yield of 70 barrels a day, or a total of 2100 barrels. Reducing the number of cycles in the allotted time to 28.5, or 25 hours for a cycle, the scale wax yield may be raised to 80 barrels a day, or a total of 2280 barrels.

Oversweating—Oversweating with loss of finished scale wax to intermediate sweat fraction seldom occurs through negligence of the operator. When the maximum sweating temperature has been reached, he sends a sample to the laboratory for testing and waits until he receives news that specifications have been met. In the meantime sweating continues at the maximum temperature. If the laboratory report comes several hours late, a considerable loss has been suffred, and melting point and oil and moisture of the wax may be far better than desired. Should oil and moisture content be high while the melting point is normal, sweating is continued, and the melting point of the wax increases correspondingly. A few examples (Table 9) make this clear. Specifications were melting point 132-134° F., oil and moisture 0.5 percent maximum.

TABLE 9

	Melting Point °F.	Oil and Moisture Percent	Yield Percent of Slack Wax
1	134	0.33	34
2	135	0.15	27
3	135	0.20	35
4	135	0.45	30
5	136	0.53	19
6	137	0.60	20
7	138	0.23	26

Sweat No. 1 yielded 34 percent scale wax within specifications. Sweat Nos. 2, 3, 4 and 7 were over-sweated, while Sweat Nos. 5 and 6 would have required additional sweating in order to satisfy the specification for oil and moisture. Instead, they were resweated.

The first task at the beginning of an investigation is to follow the flow of the wax distillate through the plant, otherwise it is impossible to correlate press operation and scale wax yields with the properties of the charge. Usually, four to five days elapse from the moment the wax distillate goes to the chillers, to the melting down of the scale wax in the sweat house. Addition of intermediate sweat fractions to the fresh slack wax for the purpose of resweating, changes the scale wax yield for better or worse and blurs the effect of the variations in the properties of the wax distillate going to the presses. Only test runs lasting several weeks with distillates of constant properties will give a picture of the influence of the distillation range, the viscosity, or the contamination with undesirable compounds.

Continuous, speedy and accurate testing is essential, particularly at the source of potential troubles, the still. A viscosimeter at this point is of much help for a check of the unit. Information is gained more quickly than by sending samples to the laboratory. Microscopic examination of the wax crystals in polarized light is useful but should not be relied upon as a sure guide. Crystals of very different forms may give identical results at the presses. The only certain indication of what may be expected in the sweating operation is the oil content of the slack wax. Speedy testing of the scale wax for oil and moisture content and melting point prevents loss of time and yield.

When the wax plant is idle, all defects noticed during operation should be repaired. A sharp-sighted supervisor sees bad leaks in hidden places and is much gratified by the improvement derived from repair. Press blankets are washed with naphtha of high aromatic content, those perforated are replaced, and twisted press plates are straightened.

Good human relations are essential. An operator who knows that his boss is friendly and listens to suggestions will come forth with surprisingly good ideas. His occupation is restricted to a small area and he has time to observe details that escape the casual visitor. The simple tests for predicting the scale wax yield from the appearance of the charge on the sweat pans are the brain children of an intelligent working man.

One has to apply psychology in his relations with his fellow workers. Any criticizing remark to a sensitive still superintendent or to a proud chief chemist may be as harmful as a high resin content of the wax distillate.

When data of comparative tests have been gathered and tabulated, it is quite understandable that they are first used to prove pet ideas. It is almost unbelievable how long these fancies can keep alive, all evidence to the contrary. Greatest caution against hasty conclusions is necessary, and discrepancies in results must not be discarded as "freaks." In his reports, the technologist should point out these irregularities and he should use them as the basis of further investigations.

In conclusion, so many factors influence the production of wax by pressing and sweating that only general rules can be given. An active technologist contributes much to the reduction of extreme fluctuations by constant watchfulness and consultation of the files. Unfortunately, he is not a universal instrument capable of recording at every moment everything going on.

The use of pour point depressants may bring considerable relief to a wax plant in trouble. Double pressing becomes unnecessary. The lower-melting waxes remain in the hot pressed liquid phase, increasing its volume.

A wax of high melting point can be made by dissolving the slack wax in warm naphtha, chilling the solution to a pre-determined temperature and pressing. The remaining solution of wax in naphtha is chilled to a lower temperature and pressed again, yielding a second crop of scale wax of lower melting point.

End of Part I. Part II will appear in an early issue.

* * *

A Test for Polysulfides in Gasoline

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THERE APPEARS to be no satisfactory test described for the detection of polysulfides in gasoline. These materials are formed during the doctor process and have a greater effect in decreasing the lead susceptibility of the gasoline, than the original mercaptans or the disulfides.[1] A test which can detect these polysulfides can therefore be of assistance in the control of the doctor process.

SMITH et al[2] observed that polysulfides interfered with the turbidimetric determination of tetraethyl lead in gasoline based on the reaction of the tetraethyl lead with alcoholic silver nitrate. The work reported here was carried out to see if the reagent could be applied to the detection of polysulfides in the absence of tetraethyl lead.

Discussion of Results

The results obtained indicated that alcoholic silver nitrate was a suitable reagent for the detection of polysulfides in gasoline. The only serious interference with the test (Table 1) was by those materials which are not normally added to the gasoline until after the final stages of treatment.

Mercaptans interfered by precipitating white silver mercaptides but could be removed completely by washing the sample with aqueous silver nitrate solution prior to testing.

Reduction of the ethanol content of the reagent to 85 percent eliminated interference by reduction of the silver nitrate by tar acid oxidation products which were probably ortho and para dihydric phenols.[3] However, further dilution reduced the sensitivity of the test, 70 percent ethanol being close to the lower limit for the reagent to be effective.

Although elemental sulfur interfered with the turbidimetric determination of tetraethyl lead by means of the reagent it did not interfere in the absence of tetraethyl lead. This indicates that the interference observed by Smith et al.[2] was due to interaction between the sulfur and the colloidal silver which is the end product of the reaction of the reagent with tetraethyl lead, and not to interaction between the sulfur and the alcoholic silver nitrate.

When samples of gasoline containing polysulfides were shaken with elemental mercury a black precipitate formed even though the gasoline gave a negative Sommer test (sensitivity 2 p.p.m. elemental sulfur[4]). This treatment had a slight effect on decreasing intensity of the color of the test with alcoholic silver nitrate. The reason for this is unknown, as is also the reaction involved between the polysulfides and the alcoholic silver nitrate. However, it seems possible that the alcoholic silver nitrate may react with tri-, tetra- and penta- sulfides and that the mercury reacts with only the penta-, or penta- and tetra- sulfides. This hypothesis would be exceedingly difficult to prove because of the great difficulty in preparing samples of each class of polysulfide uncontaminated by members of the other classes.

However, from the results of this work it can be safely taken that alcoholic silver nitrate is a specific reagent for the higher polysulfides in gasoline in the absence of tetraethyl lead and high oxidation inhibitor concentrations.

TABLE I
Interference by Various Materials

Substance Tested	Concentration Tested	Interference	Why Tested	Remarks
Mercaptans	2 ppm+	White ppt. of AgSR.	Common Constituent.	May be removed by prior wash with aqueous $AgNO_3$
Elemental Sulphur	100 ppm	Nil	Sometimes present	Interfered with TEL determination[2]
Tar Bases	To 10 percent	Nil	Constituent	
Peroxides	High*	Nil	Oxidation Product	
Aldehydes	One percent	Nil	Oxidation Product	Formaldehyde turned reagent brown on heating.
Phenol	0.5 percent	Nil	Constituent	
Cresylic Acid	0.5 percent	Nil	Constituent	
Catechol	c.0.1 percent	Nil	Can give mirror [3]	$AgNO_3$ in 95 percent ethanol reduced to mirror[3]
Resorcinol	c.0.1 percent	Nil		
Hydroquinone	c.0.1 percent	Nil	Can give mirror [3]	$AgNO_3$ in 95 percent ethanol reduced to mirror[3]
Colored gasoline oxidation products	.....	Reduced sensitivity by dissolving and discoloring the reagent	.....	Washing with 50 percent alcohol reduced interference
Aniline	0.5 percent	Nil	Aviation gasoline additive	
UOP Inhibitor No. 1	0.1 percent	Amber color black ppt.	Additive	Interference removed by wash with 2N NaOH in 50 percent ethanol.
UOP Inhibitor No. 4	Saturated 0.1 percent	Purple color black ppt.	Additive	Interference reduced by wash with NaOH in 75 percent ethanol
UOP Inhibitor No. 5	0.1 percent	Purple color black ppt.	Additive	Interference reduced by wash with 90 percent ethanol
Du Pont Copper deactivator	Saturated 0.1 percent	Green color	Additive	Interference removed by 50 per cent ethanol wash
Tetraethyl Lead	0.1-0.5 ml/gal.	Yellow to brownish black color	Additive	

(*) Test carried out on sample of olefenic gasoline that had been subjected to oxidation with oxygen. It gave very strong qualitative tests for peroxides with potassium iodide, etc.

Experimental

1) Reagent: The reagent was prepared by dissolving 5 gm. silver nitrate in a minimum of water and making up to 100 ml. with ethanol and water so that the final solvent contained approximately 85 percent ethanol.

2) Polysulfide Solution: Doctor-sweetened cracked shale gasoline was used without further treatment as the polysulfide solution. Occasional samples failed to react with the reagent indicating that the doctor sweetening process did not invariably give rise to polysulfides. Since the initial mercaptan content of the gasoline was approximately 0.0002 M (0.01 percent S by wt.) the maximum polysulfide content would be 1×10^{-4} M and the actual

microspheres two samples of different particle shape, hardness, and attritability; and the used catalysts material content would probably be much less. For lack of a suitable analytical method the polysulfide concentration could not be determined.

3) Method of Test: Five ml. of the polysulfide solution were shaken with 1 ml. of the reagent for one minute and then allowed to stand. The lower reagent layer darkened to brown or violet in the presence of polysulfides. Sometimes green or pink colors were obtained due to the presence of interfering materials.

4) Testing for Interference: Reference fuel grade iso octane did not react with the reagent under any of the conditions tried so the effect of possible interfering materials was carried out in solution in iso octane. The results are given in Table 1.

5) Dilution of Reagent: As the water content of the reagent was increased beyond 20 percent by volume the intensity of the color from the test decreased. With 30 percent water only a slight color was formed and, with 40 percent water, there was no reaction with the polysulfides.

When 95 percent alcohol was used as the solvent for the silver nitrate it gave a silver mirror in the presence of tar acids. This appeared to be due to the reduction of the reagent by the oxidation products of the tar acids. The use of 85 percent ethanolic silver nitrate eliminated this trouble. It has been shown elsewhere[3] that silver nitrate in 95 percent alcoholic solution gives a silver mirror with ortho and para dihydric phenols.

ACKNOWLEDGMENTS

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REFERENCES

[1] Livingston, H. E., Oil and Gas J., **46**; 56-57, (March 11, 1946).
[2] Smith, V. A., Delaney, W. E., Tancig, W. J., and Bailie, J. C., Anal. Chem., **22**; 1230-1231, (1950).
[3] Wildi, B. S., Science, **113**; 188, (1951); U.O.P. Lib. Bull. Abs., **26**; 44, (1951).
[4] Mapstone, G. E., Ind. Eng. Chem., Anal: Ed., **18**; 498-499, (1946).

* * *

Tiny Still Developed by Texas Company Research Staff

Now you see it, now you don't . . ."

The pitchman's come-on could well describe the here-and-gone action of some very low volatility materials under ordinary distillation.

In order to control such rapid decomposition and still carry out necessary analysis, the Beacon (N. Y.) Laboratories of The Texas Company recently turned out a miniature refining unit which is no larger than the palm-and-finger span of your hand.

The tiny still is a good example of the "last resort" ingenuity of petroleum research. It permits fairly simple molecular distillation of micro samples.

Not long ago Texaco faced the problem of analyzing a lubricant sample which wasn't big enough to make a respectable spot on a shirt front. The sample, which weighed only 0.7 of a gram, was "run to still" just as a thousand barrels might be in a refinery. After distillation, one-third was collected as condensate for further minute studies and the residual "bottoms" were also gathered up for analysis.

In the minature refinery unit either water or liquid nitrogen is used as the coolant for the condensing surface. The heat applied ranges from a few degrees above room temperature to 200 degrees Centigrade.

In molecular distillation the pressure is so low that the mean free path of the molecules is greater than the distance from the charge bed to the condensing surface.

A stillman working on one of the huge multi-story units at any of Texaco's big refineries might well scratch his head over a processing report where the charge stock weighed less than a pinch of salt.

Claude Reed of the Analytical and Testing Department at Texaco's Beacon, N. Y., Laboratories holds a special refining unit used for distilling minute samples of low volatility materials. Ordinary distillation would decompose such material and prevent analysis.

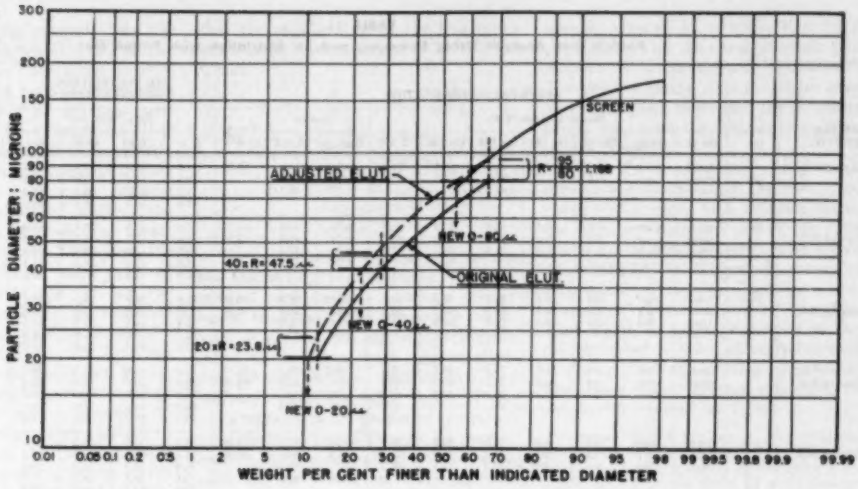

Figure 4. Particle size Distribution Catalyst Sample B-3.

IMPROVED METHODS FOR—

The Particle Size Analysis of Fluid Cracking Catalysts

Part III

F. EMERSON IVEY, JR.
The Davison Chemical Corporation, Baltimore

EFFICIENT OPERATION of fluid catalytic cracking units is greatly assisted by an accurate knowledge of the particle size distribution of the catalyst in use. A variety of analysis means developed to serve this need produce a variety of results. The analysis method reported here, developed specifically to meet requirements of a catalyst manufacturer is, in the opinion of the manufacturer's staff, "the best method we have seen to date for determining accurately the particle size analysis of our fluid type petroleum catalysts." General adaptation of this method of particle size analysis is their hope.

Part I of the three-part discussion appeared in the June issue and Part II in the July issue.

HAVING selected a standard air rate for the elutriation procedure, an attack was then made on the density effect. In developing the technique for compensating for catalyst density, preliminary rationalization took the following course:

1) As the data in Table 6 demonstrate, a air elutriation test shows a variable deviation from the corresponding screen analysis. It was reasoned that since the fritted disc modification substantially eliminates the effect of attrition and hardness, then the discrepancy between screen and Roller data at the same particle size level could be used to develop a correlation with density.

2) Although the particle density can be calculated from chemical and physical measurements, the complexity of these methods precludes their use on a routine basis for each particle size distribution analysis. However, it is reasonable to expect that changes in chemical constitution and pore volume should also be reflected in a more easily measureable density such as the familiar compacted density.

3) The change in particle density due to adsorption of water vapor during elutriation with 60 percent relative humidity air can be readily calculated knowing the initial density, the initial total volatile analysis, and the total volatile content after elutriation. Such a calculation is completely rigorous.

Upon these basic premises, a program of tests was designed to establish whether a sound correlation could be achieved, reasoning that a significant correlation would then serve as de facto verification of the assumptions. First, it was necessary to establish the rate of moisture adsorption during elutriation with 60 percent relative humidity air. The data in Table 10 show the total volatile content of each fraction of six of the catalysts previously discussed under the subject of the effect of air humidification. It is seen that although a small adsorption gradient does exist during the test, equilibrium is nearly reached during the separation of the first fraction. Thus, if the total volatile content of the 40-80 micron fraction is used to represent the total volatile of the entire sample after testing, the average error is approximately ± 0.8 percent, which at the 0.7 density level is equivalent to ± 0.007 grams per cubic centimeter (0.44 pound per cubic foot). This is insignificantly small, as reference to the final correlation shows.

To establish the density correlation, a series of 12 catalyst samples were prepared. These catalysts were specially chosen to represent as wide a spread in density, manufacturing source, and physical condition as could be found. The *B* series represent six catalysts of varying density manufactured by one process; the *C* series two catalysts of widely different particle size distribution and density manufactured by a second process; the

TABLE 11

Particle Size Analysis Using Screening and Air Elutriation with Fritted Disc

SAMPLE IDENTIF.	Run No.	AFTER PREHUMIDIFICATION: Screen Analysis (U.S) On 40	On 60	On 80	On 100	On 140	On 200	T 200	Density Gms./cc	Lb./c.f.	T.V. @ 1750 °F.	AIR ELUTRIATION AS DETERMINED: 9.0 L./Min. Air 0-20	20-40	40-80	80+	T.V. of 40-80 @ 1750 °F.	Elut. Density	Density Ratio = R
Ground B-1	1	trace	trace	1.2	9.6	28.3	45.8	54.2	0.74	46.2	15.25	11.0	14.4	34.8	39.8	21.56		
	2	trace	trace	0.8	9.2	27.5	44.6	55.4	0.74	46.2		10.8	14.4	35.0	39.8	21.41		
	3								0.74	46.2		11.2	15.0	35.8	38.0	20.25		
	4											11.4	14.5	36.1	38.0	20.69		
	Ave.	trace	trace	1.0	9.4	27.9	45.2	54.8	0.74	46.2	15.25	11.1	14.6	35.4	38.9	20.98	0.794	1.063
Ground B-2	1	trace	trace	0.8	6.0	21.5	39.8	60.2	0.75	46.8	13.50	12.6	15.7	35.8	35.9	22.51		
	2	trace	trace	0.8	6.0	21.6	38.8	61.2	0.76	47.4		12.7	16.0	35.4	35.9	22.15		
	3								0.76	47.4		12.8	15.7	36.4	35.1	20.93		
	4											12.9	16.3	35.8	35.0	21.36		
	Ave.	trace	trace	0.8	6.0	21.6	39.3	60.7	0.757	47.2	13.50	12.8	15.9	35.8	35.5	21.74	0.836	1.012
Ground B-3	1	trace	0.4	1.6	9.5	28.0	45.7	54.3	0.64	39.9	13.11	12.5	15.8	37.5	34.1	20.28		
	2	trace	0.8	2.4	10.6	28.6	46.6	53.4	0.64	39.9		12.4	16.0	37.5	34.2	20.36		
	3								0.65	40.6		12.7	16.0	37.3	34.0	20.50		
	4											12.8	16.1	38.6	32.6	19.36		
	Ave.	trace	0.6	2.0	10.1	28.3	46.2	53.8	0.647	40.4	15.11	12.6	16.0	37.7	33.7	20.12	0.688	1.188
Ground B-4	1	trace	trace	0.4	3.5	23.7	40.7	59.3	0.74	46.2	14.83	12.9	16.0	36.0	35.1	21.29		
	2	trace	trace	0.4	4.4	22.5	39.8	60.2	0.75	46.8		13.8	15.3	36.3	34.6	21.40		
	3								0.75	46.8		13.8	15.8	35.8	34.6	21.44		
	4											13.4	15.7	36.6	34.3	22.46		
	Ave.	trace	trace	0.4	6.0	23.1	40.3	59.7	0.747	46.6	14.83	13.5	15.7	36.2	34.6	21.65	0.812	1.038
Ground B-5	1	trace	0.4	1.2	7.5	26.2	44.9	55.1	0.78	48.6	13.82	11.1	13.9	36.3	38.7	21.33		
	2	trace	0.4	0.8	6.8	25.5	43.8	56.2	0.77	48.0		10.6	14.7	36.3	38.4	20.72		
	3								0.78	48.6		10.6	13.4	36.5	39.5	21.28		
	4											10.9	14.3	36.5	38.3	20.45		
	Ave.	trace	0.4	1.0	7.2	25.9	44.4	55.6	0.777	48.5	13.82	10.8	14.1	36.4	38.7	20.95	0.847	1.037
Ground B-6	1	trace	trace	0.4	7.3	22.7	38.1	61.9	0.68	42.4	17.93	16.1	18.1	35.6	30.2	20.97		
	2	trace	trace	0.8	7.6	22.8	38.4	61.6	0.69	43.1		16.3	19.2	37.6	26.9	19.71		
	3								0.68	42.4		16.3	19.2	36.5	28.0	19.77		
	4											16.9	17.8	36.7	28.6	20.08		
	Ave.	trace	trace	0.6	7.5	22.8	38.3	61.8	0.687	42.8	17.93	16.4	18.6	36.6	28.4	20.13	0.707	1.162
Microspheres A	1	Average of 14 Runs							12 Tests Made			0.1	13.8	72.6	13.5	24.25		
	2											0.3	14.7	72.2	12.8	25.26		
	3											0.1	13.7	72.3	13.9	23.98		
	4											0.2	13.9	72.8	11.2	23.83		
	Ave.	0.5	1.2	1.7	2.4	6.6	22.4	77.6	0.72	44.9	18.37	0.2	14.5	72.5	12.8	24.33	0.777	1.088
Microspheres B	1	0.0	....	0.0	trace	4.0	16.3	83.7	0.71	44.2	17.90	0.5	14.2	76.4	8.9	24.46		
	2	0.0	....	0.0	trace	4.0	18.7	81.3	0.72	44.9	17.91	0.2	14.6	77.0	8.2	24.38		
	3											0.3	16.3	75.6	7.8	23.37		
	4											0.2	15.0	77.2	7.6	23.73		
	Ave.	0.0	....	0.0	trace	4.0	17.5	82.5	0.715	44.6	17.91	0.3	15.0	76.5	8.1	23.99	0.772	1.125
Ground F-1	1	0.0	trace	trace	0.4	4.4	20.9	79.1	0.73	45.6	15.38	16.9	19.3	53.7	10.1	19.50		
	2	0.0	trace	0.4	0.8	4.8	21.7	78.3	0.73	45.6	15.25	17.3	19.8	54.6	8.3	17.96		
	3								0.73	45.6		16.9	19.2	54.7	9.2	18.04		
	4											17.7	20.0	54.3	8.0	17.15		
	Ave.	0.0	trace	0.2	0.6	4.6	21.3	78.7	0.73	45.6	15.32	17.2	19.6	54.3	8.9	18.18	0.756	1.121
Ground C-2	1	0.0	trace	0.8	3.2	22.9	50.6	49.4	0.70	43.7	13.65	8.3	11.0	42.9	37.8	16.97		
	2	0.0	trace	0.4	3.2	23.3	50.6	49.4	0.71	44.2	13.60	7.6	11.2	44.3	36.9	16.94		
	3								0.70	43.7		7.9	10.5	44.2	37.4	15.87		
	4											8.3	10.8	45.1	35.8	17.58		
	Ave.	0.0	trace	0.6	3.2	23.1	50.6	49.4	0.707	43.9	13.63	8.0	10.9	44.1	37.0	16.84	0.734	1.107
Used Ground F-1	1	0.0	0.0	0.0	0.0	1.6	14.8	85.2	1.03	64.3	1.40	2.3	16.6	58.2	22.9	2.27		
	2	0.0	0.0	0.0	0.0	1.6	14.8	85.2	1.03	64.3	1.52	2.8	17.9	56.7	22.6	2.27		
	3								1.05	65.6		2.5	16.7	57.5	23.3	1.96		
	4											2.6	17.1	58.2	22.1	2.12		
	Ave.	0.0	0.0	0.0	0.0	1.6	14.8	85.2	1.04	64.7	1.46	2.6	17.1	57.6	22.7	2.15	1.047	0.925
Used Ground	1	trace	trace						0.97	60.5	1.49	10.7	27.1	50.7	11.5	2.48		
	2	trace	trace						0.97	60.5	1.52	10.5	27.4	50.9	11.2	2.60		
	3								0.97	60.5		11.0	26.3	50.5	12.2	2.59		
	4											10.0	26.8	50.5	10.7	2.55		
	Ave.	trace	trace	0.4	0.8	3.2	10.5	89.5	0.97	60.5	1.51	10.6	27.4	50.6	11.4	2.53	0.980	0.900

of extremely high hardness and density. Thus the complete range of all variables which can be anticipated in catalytic materials has been encompassed, the purpose being to present the most extreme demands to the correlation. From these 12 large samples, 12 pairs of duplicate one-quart samples were prepared and codified identification placed on the jars. One of each pair was then submitted to the laboratory for a single screen analysis, duplicate elutriation analyses using the fritted disc and 60 percent relative humidity air, duplicate compacted density measurement, and duplicate total volatile analyses on the original sample and the 40-80 micron fraction. At the completion of this series, the second sample of each pair was submitted for the same tests, but these samples bore different coding from the first set. By this means, absolutely impartial handling of the analyses was assured, since only the Quality Control Group was aware of the true identification of the samples. The resultant data are tabulated in Table 11. Using the average of all the data on each of the twelve catalysts, the compacted densities were corrected for moisture adsorption to give what we shall call the "elutriation density," using the relationship:

$$\rho_E = K \frac{100 - A}{100 - B}$$

where: ρ_E = Elutriation density in grams per cubic centimeter

K = Compacted density in grams per cubic centimeter

A = Total volatile content of the untested sample in weight per cent

B = Total volatile content of the 40-80 micron fraction in weight per cent.

The screen and elutriation data were plotted on logarithmic-probability coordinates, since it is generally accepted that above 10 microns fine powders are characterized by this type of size distribution. A typical example is presented as Figure 4.

At this point it is necessary to decide upon the nature of the index which shall be used to describe the deviation between the screen and the elutriation data. One such index was already available; the Roller

ratio, defined as the ratio of "on 200 mesh" to 80+ microns by the Roller analysis. This was considered unsatisfactory because the ratio is based upon the weights present at different particle diameters. It was reasoned that the elutriation apparatus is essentially a means of measuring particle diameters, and that a change in particle density has the effect of shifting the magnitude of the diameter as measured at fixed conditions. Therefore, the desirable index should be a ratio of particle diameters by the two analytical methods. Accordingly, the so-called Density Ratio R was adopted and defined as the ratio of the particle diameter taken from the screen analysis curve at the weight percent level of the elutriation 80 micron fraction, to 80 microns. Attention is also called to the fact that, since the Density Ratio considers a section of the screen curve between the 100 and 200-mesh points, the effect of the bias created by the 200-mesh sieve is considerably reduced. Therefore a closer agreement with the true diameter is obtained than would be expected from the 200-mesh screen alone. The indices for the 12 catalyst samples are shown in Table 11, and the method of determining one of them is illustrated in Figure 4.

The "elutriation density" and the "density ratio" are then available for correlation. The resulting plot is shown in Figure 5. The narrow band of dispersion of the plotted points around the line is outstanding. By calculation, the correlation coefficient was found to be —0.987, i.e., the statement that a correlation of these two variables exists can be made with better than 99 percent confidence. The square of the correlation coefficient also leads to the conclusion that 97.4 percent of the variation in the ordinate is explained by the variation in the abscissa. The equation of this line was calculated by the method of least squares assuming that the line required is that which gives the best estimate of the ordinate from a given value of the abscissa. The equation is:

$$R = 1.854 - 0.982\rho_E$$

Where: R = Density ratio
ρ_E = Elutriation density: grams/cc.

Of immediate concern was the fact that this correlation of elutriation density vs. change in measured diameter is a straight line. It has already been shown that the Stokes Law relationship is a square root function. If both these observations are correct, then it must mean that the relationship of ρ_s to ρ_E (the elutriation density) is other than a straight line. It has been mathematically derived that such a condition can exist and further that the relationship of the two types of density measurements is of the form:

$$\rho_E = \frac{a}{b} - \frac{1}{b f(\rho_s)}$$

where: ρ_E = Elutriation density
$a = 1.854$ = Intercept of correlation line (Figure 5)
$b = 0.982$ = Slope of the correlation line (Figure 5)
ρ_s = Particle density

The correlation provides a means for correcting the diameter of 80+ micron particles to a common density basis. However, it is obviously necessary to correct the entire distribution curve to the same basis. Rationalization of the physical factors involved indicates that this same factor R applies equally to all points of the measured distribution, although its magnitude is developed entirely from work with the 80+ micron fraction. The Stokes Law relationship between particle diameter and density is independent of the magnitude of the diameter; the effect on measured diameter of a specific change in particle density is percentage-wise the same whether particle be 20 or 80 microns in diameter. The density ration R is therefore used as a multiplier to correct the diameter of all points on the distribution curve to base density.

While the mechanism is thus made available for adjusting the measured particle diameters to a uniform basis, the resultant data are not of the type which are generally useful. The above procedure adjusts the end diameters of each measured catalyst fraction to new diameters at the measured weights. That which is actually desired is the the corrected weights of each fraction at the original end particle diameters. The transformation from one basis to another is derived as follows:

Assume that a variate d (the particle diameter) is distributed logarithmico-normal, i.e., that log d is distributed normally, and that the form of a frequency function is given by:

$$f(y) = \frac{1}{\sqrt{2\pi}\,\sigma} e^{\frac{-(y-m)^2}{2\sigma^2}}$$

Figure 5. Effect of Catalyst Density During Air Elutriation.

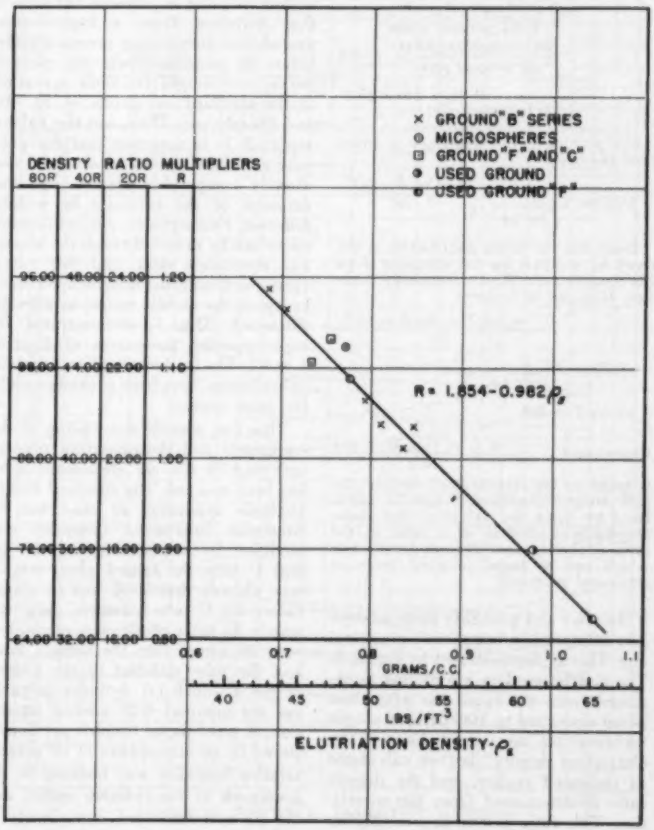

TABLE 12

Theoretical Effect of Air Rate in Roller Apparatus

Fixed Conditions:

g: Accel. of Gravity = 980 cms./sec.^{2}

ρ: Density of Air = 1.165 x 10^{-3} Gms./cc. @ 75° F.

μ^3: Viscosity of Air = $(1.888 \times 10^{-4})^2$ poises @ 60 percent Relative Humidity and 75° F

Stokes Law:

$$V = \frac{D_p^2 g(\rho_s - \rho)}{18\mu}$$

Binder's Correlation:

$$B = \sqrt{\frac{4D_p^3 g\rho(\rho_s - \rho)}{3\mu^2}} = ReC_{1,2}$$

Walker, Lewis, McAdams, Gilliland Correl.:

$$f(Re)^2 = \frac{4gD_p^3\rho(\rho_s - \rho)}{3\mu^2}$$

Maximum Particle Dia., D_p: Cm. Roller Cylinder Diameter D_c: Cm.	2×10^{-2} 11.42			4×10^{-2} 5.71			8×10^{-2} 2.857			8×10^{-2} 3.175		
Pore Volume: Cc/gm.	0.35	0.45	0.55	0.35	0.45	0.55	0.35	0.45	0.55	0.35	0.45	0.55
Particle Density: ρ_s	1.440	1.282	1.153	1.440	1.282	1.153	1.440	1.282	1.153	1.440	1.282	1.153
$B = 0540\sqrt{\rho_s D_p^3}$	.....	.....	.....	1.997	1.870	1.779	5.61	5.30	5.02	5.61	5.30	5.02
$f(Re)^2 = 427 \times 10^6 \rho_s D_p^3$	0.492	0.438	0.394	3.94	3.50	3.16	31.50	28.02	25.23	31.50	28.02	25.23
Re: from "B" Number	.....	.....	.....	0.15	0.135	0.124	1.15	1.05	0.96	1.15	1.05	0.96
from $f(Re)^2$	0.0216	0.0190	0.0173	0.167	0.149	0.134	1.09	0.99	0.90	1.09	0.99	0.90
$\frac{Re_0}{D_{p0}} = \frac{0.1620\ Re}{D_p}$: from "B"	.....	.....	.....	6.07	5.46	5.02	23.3	21.3	19.43	23.3	21.3	19.43
from $f(Re)^2$	1.750	1.540	1.400	6.76	6.04	5.42	22.1	20.05	18.22	22.1	20.05	18.22
Rate = $\frac{Area_c \times V \times 60}{1000}$: from "B"	.....	.....	.....	9.33	8.40	7.72	8.96	8.20	7.48	11.10	10.13	9.25
from $f(Re)^2$	10.71	9.44	8.58	10.40	9.27	8.34	8.30	7.72	7.02	10.80	9.55	8.69
from Stokes Law	10.20	9.09	8.18	10.20	9.09	8.18	10.20	9.09	8.18	12.61	11.23	10.12

where: m = log geometric mean diameter
= 50 percent point of original distribution plotted on log-probability paper

σ = log geometric standard deviation

$$= \frac{50 \text{ percent point}}{15.87 \text{ percent point}} = \frac{84.13 \text{ percent point}}{50 \text{ percent point}}$$ of the original distribution plotted similarly.

For $y = \log d$, the frequency function then becomes

$$f(d) = \frac{1}{\sqrt{2\pi}\ d\sigma}\ e^{\frac{-(\log d - m)^2}{2\sigma^2}}$$

Since the corrected distribution is derived by multiplying the diameter d by the density ratio R, the frequency function $f(Z)$ can be written:

$$f(Z) = \frac{1}{\sqrt{2\pi}\ Z\sigma}\ e^{\frac{-(\log Z - \log R - m)^2}{2\sigma^2}}$$

where $Z = Rd$

Consequently, if $\frac{\log Z - (\log R + m)}{\sigma}$ is taken as the standardized deviate, the new weight distribution can be calculated by using the values of the above standardized deviate in a table of the areas of the standard normal-distribution which can be found in most texts on statistical methods.

Another and probably more convenient solution is a completely graphical one. This is demonstrated in Figure 4. The elutriation data are plotted as obtained from the apparatus after first being corrected to 100 percent weight recovery on an output basis. "The elutriation density" is then calculated as indicated earlier, and the density ratio is determined from the correlation. This ratio is used as a multiplier with the 20, 40, and 80 micron diameters, giving new diameters which are plotted at the determined weight fraction cut points. Through these points a smooth curve is drawn, placing any existing curvature at the fine end. This is done because experience has shown that deviation from a logarithmic-probability distribution occurs chiefly below 20 microns. From the plotted curve, new weight fractions are read at the standard cut points of 20, 40, and 80 microns. These are the values reported. It is apparent that the particle size distributions so obtained are directly comparable even though the densities of the catalysts be widely different. Furthermore, one continuous curve can be drawn through the screen and elutriation data, and this curve agrees well with the microscope count, except in the middle range, as already discussed. This is demonstrated by superimposing the curves of Figures 1 and 2. The mathematical and graphical solutions have been proved to yield the same answer.

Thus far, specific description of the equipment and the operating procedure used in the air elutriation work has been avoided. The standard Roller analysis apparatus as marketed by American Instrument Company was modified by substituting for the jet and U tube the fritted glass sample tube already described, and by eliminating the U tube hammers. Approximately 15 cubic centimeters of catalyst were measured into the sample tube, and the tube attached to the bottom of the 4½-inch i.d. cylinder to carry out the nominal 0-20 micron separation. A tared-paper thimble previously stored in an atmosphere of 60 percent relative humidity was fastened to the gooseneck at the cylinder outlet, and the air rate advanced immediately to 9 liters per minute. Elutriation was continued for exactly 20 minutes at which time the air was turned off and the thimble weighed. The 2¼-inch i.d. cylinder was then placed in service with a fresh tared and humidified paper thimble, and the nominal 20-40 micron fraction similarly removed in 20 minutes. The sequence was repeated using 1⅛-inch i.d. cylinder for the removal of the 40-80 micron fraction. The material remaining in the fritted glass sample tube after the removal of the 40-80 micron fraction was weighed and reported as 80+ microns. The determined weights of each fraction were all corrected to 100 percent weight recovery on an output basis and these values were then adjusted for density as previously described to obtain the final reported analysis.

Two controversial points are involved in this procedure: the use of a definite time interval for separating each fraction, and the use of a 1⅛-inch i.d. cylinder for the split at 80 microns. Concerning the technique for determining fraction cut points, two methods are generally used: the "time interval" method which involves running for a fixed time, and the "end point" method which comprises running until no more than 0.1 gram (approximately 1.5 weight percent of sample) passes overhead in an additional five minutes. The data presented in Table A indicate that in the case of the procedure described above, a time interval of 20 minutes per cut is synonymous with the end point method, since the maximum change in any fraction caused by 5 additional minutes was only 0.5 weight percent.

Therefore, it is felt that ample justification exists for accepting a fixed 20-minute time interval for the separation of each fraction.

TABLE A

Particle Range: Microns	0–20		20–40				40–80		
Time: Minutes in excess of 20	5	10	5	10	15	20	5	10	15
Change in weight: Percent of sample	+0.1	+0.8	+0.5	+1.14	+2.0	+3.0	−0.2	−1.3	+0.3
Number of tests	33	1	19	1	1	2	17	8	2

Note: Data obtained in conjunction with runs summarized in Table 11.

A second point of confusion in the Roller apparatus is the diameter of the cylinder used to make the 80 micron split. The cylinder originally marketed was 1⅛-inches i.d. but at a later date the diameter was increased to 1¼-inches. In spite of this change by the supplier, our laboratory and others have continued to use the 1⅛-inch cylinder, a decision which is justified both by the cleanness of the separation of the fractions as previously indicated in Table 9 and by the theoretical considerations which follow.

Returning to Stokes Law, it is apparent that since velocity is a direct function of the square of the particle diameter and also is an inverse function of the square of the cylinder diameter, then the cylinders used to separate to 10, 20, 40, and 80 microns should be sized in multiples of 8, 4, 2 and 1 respectively. This apparently was the basis for the design of the original Roller cylinders. However it is generally accepted[10,11,12] that above a Reynolds number of 0.4 (equivalent to about 60 microns for the particle densities normally encountered), deviations from the Stokes Law relationship develop. Several empirical methods for calculating above this range have been published, among them those by Binder,[10] and Walker, Lewis, McAdams, and Gilliland.[11] The results of calculations using these correlations in contrast to the uncorrected Stokes Law are shown in Table 12, and are presented graphically as Figure 6. It is immediately apparent that the two correlations give exactly opposite directive concerning the correct diameter of the smaller cylinder. However, work by Matheson[12] has indicated that "Binder's method agrees with experimental results over a large range of particle sizes and particle densities." In view of this theoretical background, the work herein reported was carried out using a 1⅛-inch diameter cylinder for the 80-micron separation. As previously mentioned, the separation efficiency thereby obtained (Table 9) provides practical verification of the theory and of Matheson's work.

Final Statistical Evaluation of the Tests

Having developed apparently satisfactory screen and elutriation test methods, it was then necessary to design a statistical experiment to evaluate the over-all laboratory performance using these techniques. The following information was felt to be essential, and the statistical design was therefore made to provide these specific data:

1) Screen Test

a) Precision of the method on catalysts of different particle size distributions.

b) Effect of the matched sieves on precision and level.

c) Effect of sample preparation on precision.

2) Elutriation Test

a) Precision of the elutriation procedure on catalysts of different particle size distributions.

b) Loss in precision introduced by the total volatile and density measurements.

c) Loss in precision introduced by variance in mechanical manipulation of the data.

d) Effect of sample preparation on precision.

Three inherently different catalysts were chosen for this experiment: the ground B-6, ground F-1 and ground C-2 previously used in developing the density correlation. Three samples of each catalyst were prepared by the method previously described. One sample of each catalyst, bearing nondescriptive identification, was submitted to the laboratory for screen analy-

Figure 6

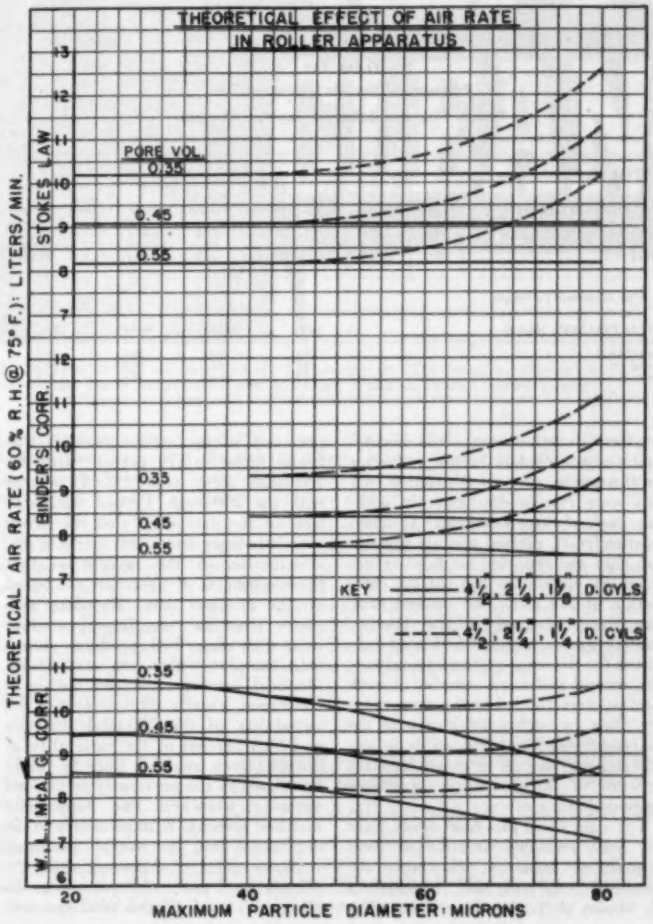

TABLE 13

Precision of the Screen Test

A. Precision (2σ Limits for Individual Determinations)

	On 100	On 200
Precision of Screening	±0.52%	±1.01%
Precision of Screening+Sampling	±0.54%	±1.08%
Precision of Screening+Sampling+Matched Sieves	±0.79%	±3.34%

B. Particle Size Distribution of Samples—Averages

	NEST No. 1		NEST No. 3		NEST No. 4	
GRIND	On 100	On 200	On 100	On 200	On 100	On 200
Ground B-6	9.6	57.3	10.2	55.3	9.3	55.4
Ground C-2	4.0	53.4	3.4	48.2	3.2	48.1
Ground F-1	0.8	20.9	0.7	18.2	0.4	17.1

TABLE 14A

Precision of the Air Elutriation Test

Precision: 2σ Limits for Individual Determinations

ACTUAL FRACTION: Microns	0-20μ	20-40μ	40-80μ	80+μ
Precision of Elutriation	±0.6%	±0.8%	±1.6%	±1.7%
Precision of Elutriation+Sampling	±0.6%	±1.0%	±1.8%	±2.1%
Precision of Elutriation+Sampling+T.V. and Density Determ.	±0.7%	±1.1%	±2.1%	±2.1%
Precision of Elutriation+Sampling+T. V. and Density+Plotting	±0.8%	±1.4%	±2.7%	±2.3%

TABLE 14B

Precision of the Air Elutriation Test

Particle Size Distribution of Samples—Averages

Before Adjustment for Density.

NOMINAL FRACTION: Microns	0-20μ		20-40μ		40-80μ		80μ	
Actual Weight and Diameter	Weight Percent	Microns	Weight Percent	Microns	Weight Percent	Microns	Weight Percent	Microns
Ground B-6	7.9	0-23.2	11.2	23.2-46.4	35.9	46.4-92.8	45.0	92.8+
Ground C-2	7.0	0-22.2	10.3	22.2-44.4	45.0	44.4-88.8	37.7	88.8+
Ground F-1	16.7	0-22.6	19.9	22.6-45.2	54.5	45.2-90.4	8.9	90.4+

After Adjustment for Density.

ACTUAL FRACTION: Microns	0-20μ	20-40μ	40-80μ	80+μ
Ground B-6	6.8	8.4	28.6	56.2
Ground C-2	6.1	8.1	34.9	50.9
Ground F-1	14.9	16.4	48.8	19.9

sis after saturation, compacted density, total volatile content before and after air elurtiation, and air elutriation. All tests were run in duplicate. In addition, each of three laboratory foremen independently plotted the air elutriation data and reported the final values for every elutriation test. At the completion of the work, the unused samples were returned to the Quality Control group, re-identified, and submitted for the same system of analyses. The second and third samples of each catalyst were treated in the same manner. Only by such organization of the analytical routine is it possible in one experimental design to obtain positive answers to the numerous questions propounded.

The data from this final study have not been included because of their voluminous quantity. However, the statistical analyses and conclusions are shown in Tables 13 and 14. The precision of the screen analysis was found to be ±0.79 percent with the 100-mesh sieve and ±3.34 percent with the 200-mesh. Proper statistical tests of the data show that the precision is independent of the particle size distribution of the sample so that these estimates of precision are based on the grouped data. The data also prove that the sampling procedure heretofore described produces duplicate samples which are statistically identical insofar as screen testing is concerned. Finally, 31.6 percent of the variability of the 100-mesh analysis and 68.6 percent of the variability of the 200-mesh analysis were found to be caused by the previously mentioned variance between the supposedly matched screens. With reference to the elutriation test, the overall precision is shown to be ±0.8 percent at the 20-micron level and ±3.3 percent at the 80-micron level. Of this total variability, 75.0 percent at the 20-micron level and 51.5 percent at the 80-micron level are due to the elutriation test, 12.5 percent at the 20-micron level and 12.1 percent at the 80-micron level to the total volatile and density analyses, and 12.5 percent at the 20-micron level and 36.4 percent at the 80-micron level to the plotting operation. As in the screen test, particle size and distribution and sample preparation were found to have no statistically significant effect on precision even though the data show a numerical difference at the 80-micron livel due to sampling. Inspection of the "on 200-mesh" content and corresponding 80+ micron content of the three test samples gives proof of the earlier statement that the screen and elutriation methods herein developed provide a continuous particle size distribution curve.

The 0-20-micron fractions of the particle size distributions, shown in Table 14B were calculated on the basis of the 4½-inch cylinder separating at 20 microns under conditions such that the subsequent cylinders separate at 40 and 80 microns. But it has already been indicated that in practice this cylinder separates at 24 microns. If this is the case, then the actual diameters shown in Table 15B are in error. However, the error can properly be handled when calculating the actual diameter by using the factor R as a multiplier of 24 microns rather than 20, and determining the over-all distribution using the diameter thus calculated with the diameters of the two larger fractions already established. When this is done, the distributions of the three catalysts shown in Table 14B become:

Actual Fraction: Microns	0-20	20-40	40-80	80+
Ground B-6	4.5	10.2	29.1	56.2
Ground C-2	4.7	9.2	35.2	50.9
Ground F-1	11.7	18.1	50.3	19.9

REFERENCES

[30] Binder, R. C., "Determining Fall or Rise Velocity of Spheres in Fluids," Chemical and Metallurgical Engineering, 51, 104, August 1944.

[31] Walker, W. H., Lewis, W. K., McAdams, W. H., and Gilliland, E. R., "Principles of Chemical Engineering," McGraw-Hill Inc., New York, 3rd. Edition, Pg. 296.

[32] Matheson, George L., personal communication, March 14, 1949.

ACKNOWLEDGMENT

In a very real way, this work has been the product of the coordinate action and thinking of a group of men, so that the recognition of their contributions is more than a mere formality. The project owes its success in a large part to: W. R. Fullem who designed the statistical experiments by which the many steps were tested and proved; A. T. Blackwell whose careful laboratory supervision and constructive suggestions made available data of the highest calibre; M. H. Replogle who has been responsible for all sampling and quality standards preparation; Dr. J. L. Anderson, Professor of Geology at Johns Hopkins University, who conducted the microscopic examination; and Dr. R. E. Taylor who pursued the sedimentation techniques. Also, we are pleased to recognize and commend G. L. Matheson of Standard Oil Development Company for his valuable contribution in initiating the use of the fritted disc and high humidification of air. It is from the continual interchange of ideas with these men and others that the project matured.

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There is another and much heavier type of formation within a tube that impairs its operation, or shortens its life, or both. This is the deposition of foreign matter such as shells, which may cause erosion-corrosion effects, and the growth of organisms such as algae. The latter materially reduce heat transfer.

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This utility is exceptionally well managed, with a systematic tube-cleaning program. However, it found that brushes and rubber plugs used for cleaning wore out quickly. Revere took a close interest in this problem. One of Revere's customers makes nylon brushes for cleaning tubes in dairies, and it was suggested that a modification of these be tried. Results: over 300 tubes cleaned per brush, a much longer life than anything previously used, and a half-inch gain in vacuum, meaning dollars and cents saved in fuel.

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REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the processing industry.

George Gibbs Named PR Associate Editor

George B. Gibbs, who became Associate Editor of PETROLEUM REFINER on September 1, graduated last month from the University of Texas with an M.S. degree in chemical engineering. Between his B.S. and M.S. degrees he sandwiched in four years of industrial experience as well as two years of Naval duty. He spent two years with The Dow Chemical Company at Midland, Mich., and Freeport, Texas, doing research and development work, and then in 1948 joined the Arabian American Oil Company for a tour of Saudi Arabia, Dhahran and Ras Tanura as a chemical engineer.

Gibbs returned to the United States in October, 1950, to undertake graduate work at the University of Texas. He was associated with the Texas Company, Lawrenceville, Ill., for a short time as a process engineer trainee before going overseas with Arabian American.

In his new assignment Gibbs will be responsible for a number of fields of activity, including natural gasoline and the light hydrocarbons, maintenance and operation, and the regular Refiner "How To Do It" section. In addition, he will also give editorial assistance along other lines.

George B. Gibbs

Mills and Shabaker Are Collaborators

Experts both when it comes to information on catalysts, H. A. Shabaker and Dr. G. A. Mills were a natural team for "Factors Controlling Aging of Cracking Catalysts," found on page 97.

Shabaker began working with catalytic experiments in 1930 when he joined the du Pont Ammonia Corporation shortly after graduation from the University of Minnesota. Then in 1931 he joined Houdry Process Corporation to participate in various phases of the early development of the catalytic cracking process. Development, production and application of catalysts for this process soon became and has remained, his major professional interest. Numerous patents issued under Shabaker's name indicate his pioneering work and activities in this field.

Dr. Mills, assistant director of research at Houdry Process Corporation, began a career associated with the petroleum industry up in Saskatchewan, Canada. A bachelor and master of science from the provincial university, he continued to Columbia University where he was awarded a Ph.D. degree for work done with Professor H. C. Urey on the separation and application of isotopes. After instructing at Dartmouth College a year, he joined Houdry in 1940. He has since engaged in catalytic research for the petroleum industry. Dr. Mills also holds numerous patents on clay and other catalysts, and in conjunction with Houdry staff members, has published technical data which served to identify the acid chemical nature of cracking catalysts, their structure and mechanism of action on hydrocarbon molecules.

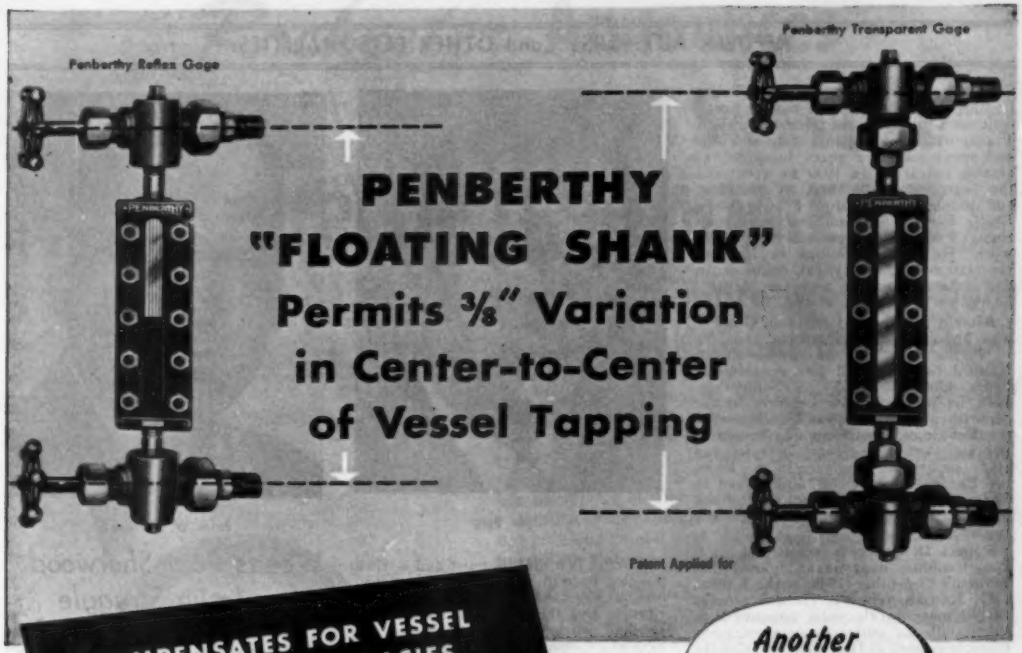
Dr. Mills is a member of the American Chemical Society, American Association for Advancement of Science, Sigma Xi, and other organizations.

Phillips Engineers Write of Gas Plants

The authors of "Modern Trends in Gas Plants for Catalytic Cracking" which appears on page 196, are both Phillips Petroleum Company process engineers who live in Bartlesville, Okla.

Forrest E. Gilmore, a 1916 chemical engineering graduate of Kansas State College, has designed and constructed 40 natural gasoline plants during his lengthy career. In 1918 he enlisted in the Signal Corps, later became a flying cadet at Souther Field, Ga. His aeronautical career cut short by the armistice, he joined the Frank P. Peterson

R. D. Bauer | Forrest E. Gilmore | G. A. Mills | H. A. Shabaker



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Company, petroleum engineers, in Tulsa. During the 1930's he was named president and manager of General Frigid Transportation Company of New York, and spent some six years doing refrigeration research. In 1939 he reentered the petroleum field, first as president and manager of Walter P. Chrysler's Black River Oil Company, and then engaged in independent oil exploration work. He joined Phillips in 1941 as correlation and analytical engineer in the Natural Gasoline and Gas department.

After a year in that position, Gilmore was appointed administrative assistant to F. E. Rice, vice president of the Natural Gasoline and Gas department. From October, 1943, to September, 1944, he was operation engineer in the department, and then was transferred to the Refining department as administrative assistant. Three years later, he was made supervising engineer in the Process Engineering division and served in that capacity until December, 1950, when he was appointed assistant chief process engineer.

Robert D. Bauer, a member of Phillips Refining department, joined the company December, 1946, at the Kansas City, Kansas, refinery. He did process development work until appointed to Bartlesville as senior process engineer. Bauer was born at Junction City, Kansas, and attended Kansas State College where he majored in chemical engineering. Before joining Phillips, he worked for a rubber company three years in the synthetic rubber division. Bauer is a member of Sigma Tau and Phi Lambda Upsilon.

Paul Zurcher

Dewaxing Series Is Report on Research

Paul Zurcher, already known to PETROLEUM REFINER readers for his contributions to the March, 1950, article entitled "Extraction of Mercaptans by Means of Adsorption," is this month author of a two part feature entitled "Notes on Dewaxing." Part I starts on page 119.

Clyde Berg

Zurcher is a multilinguist and a world traveler, born in Switzerland, whose profession has taken him to all parts of Europe and the Western Hemisphere. He had worked in Italy, France, Bolivia and Colombia prior to joining Continental Oil Company in 1927 as research technologist working with dewaxing, manufacturing of lubricants and a number of other fields. He joined the staff of the University of Tulsa in 1947 and is now teaching petroleum refining and graduate research. The current two part series is an "abstract with conclusions" from the records of his work as technologist at the Continental Oil Company plant at Ponca City, Okla.

Hypersorption Author Loves Sailboat Race

Clyde Berg is becoming PR's authority on Hypersorption. In 1949 he collaborated with three other Union Oil authors to bring PR readers "The Hypersorption Process for Separation of Gases and Vapors." His current article appears on page 241 and is entitled: "Hypersorption In Modern Gas Processing Plants."

Berg is assistant to the vice president in charge of research and development for the Union Oil Company. He earned his undergraduate degree from the University of Minnesota in 1936 and then was awarded the Hormel Research Fellowship while doing post graduate work and acting as an instructor in the chemical engineering department. Granted his Ph.D. in 1940, he entered the process design and development group as supervisor in charge of process development for Union Oil Company. He was promoted to his present position in 1949.

Under his direction a wide range of processes have been developed. He has published articles on hypersorption, retorting and refining of shale oil, catalytic refining, solvent extraction, etc.

As a change of pace, Berg goes in for sailboat racing, saving swimming and golf engagements for poor sailing days.

Peter W. Sherwood

Weeds Rout Sherwood After Lawn Struggle

The series, "Production of Ethylene from Petroleum Sources," beginning on page 228 marks the twelfth time that Peter W. Sherwood has appeared in the ranks of PR authors. Sherwood is associated with the Blaw-Knox Chemical Plants Division in Pittsburgh at present, but his background includes a number of years with Koppers Company, Inc., in the same city, and a stint as a member of the Foreign Technical Mission on Fuels and Lubricants which investigated German wartime industrial developments. In 1948 he published "High Pressure Hydrogenation in Germany," a monograph on German coal liquefaction technology.

Sherwood is a graduate of Columbia University and has published some 60 papers in the field of Chemical Engineering.

His hobbies which include swimming, golfing and gardening have evidently diverted too much of his attention. Last report from Sherwood reads: "Fighting desperate Battle of the Lawn. Wise money being bet on the Weeds."

McHose Joins OIIC

Harry William McHose, graduate of Columbia University School of Journalism, has joined the staff of the Department of Information of the American Petroleum Institute in New York as editorial director, to succeed Joseph H. Mader, resigned. McHose will be in direct charge of the preparation of informational booklets, leaflets, pamphlets and other materials produced in the headquarters office of OIIC. Until recently he operated his own public relations firm in New York.

Dyer Now Vice President

James E. Dyer, a director and vice president in charge of transportation and distribution of Sinclair Refining Company, has been elected vice president of Sinclair Oil Corporation. Dyer joined the Sinclair organization in 1916 at the time of its original consolidation.

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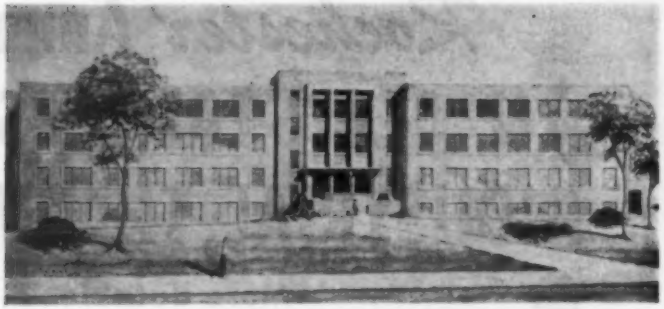


NEW LAB BUILDING—Excavation on a new $1,150,000 petroleum engineering building was begun recently for the Colorado School of Mines. The lab will house petroleum refining engineering classes; six laboratories will be set aside for the use of graduate refining students, three for students in the field, and one for faculty members doing research work in the petroleum field. Actual field conditions will be simulated by a 50-foot steel oil well derrick which will contain pumping equipment to operate a ten-inch well driven 100 feet into the ground under the building basement. This device will allow running tests on various types of deep-well pumps and gas lifts. Addition of pilot plant for petroleum refineries is now under consideration.

Dr. Haensel to Receive Petroleum Chemistry Award

Dr. Vladimir Haensel, Universal Oil Products Company, Chicago, early this month was named as the 1952 recipient of the Precision Scientific Company's Award for achievement in petroleum chemistry. Announcement of the $1000 citation was made at a Diamond Jubilee meeting of the American Chemical Society in New York. The award, which is administered by ACS, will be presented to Dr. Haensel sometime next spring.

The 37-year-old chemist is the inventor of the unique Platforming process which is currently being accorded wide acceptance throughout the petroleum refining industry. He is also the co-inventor of a process for producing Triptane. For this discovery, he received the Chicago Junior Chamber of Commerce Award in 1944.

Dr. Haensel was graduated from Northwestern University in 1935 and holds graduate degrees from that institution and Massachusetts Institute of Technology. He is the holder or co-holder of 30 patents and has published numerous articles in scientific journals since 1942. He is division coordinator in charge of Universal's Cracking Research at the company's Riverside, Ill., laboratories.

To Study Procedures Due To Iranian Oil Losses

Following governmental approval on co-operative action by the petroleum industry for offsetting Iranian oil losses, Deputy PAD Bruce K. Brown named an executive committee and five subcommittees for the Foreign Petroleum Supply Committee to work out detailed schedules for implementing operating procedures. Stewart P. Coleman of Standard Oil Company (New Jersey) was named head of the new executive committee whose membership represents nine major companies: Caltex Oil Products, Gulf Oil, Socony-Vacuum, Standard Oil (Calif.), Standard Oil (N. J.), Standard Vacuum, Texaco, Arabian American, and Sinclair. A. C. Long of Texaco was named vice chairman of the executive committee.

Brian Mead, Standard Oil (N. J.) was named chairman of the Refining committee, with the following members: H. B. Nichols, Caltex; R. S. Hatch, Arabian-American; J. D. Long, Creole; C. W. Hurley, Gulf; F. C. Fahnstock, Socony-Vacuum; R. W. Carder, Standard Vacuum; F. H. Homes, Texaco; E. L. Steiniger, Venezuelan Petroleum.

Other committee chairmen and their committees are: Production, Harry McCobb, Standard Vacuum; Materials, A. H. Chapman, Arabian-American; Bulk Transportation, T. E. Buchanan, Texaco; Overseas Liaison, Howard W. Page, Standard (N. J.).

Two Researchers Promoted

Wayne A. Proell and Dr. A. W. Weitkamp have been promoted to research associates in the Standard Oil Company (Indiana) research laboratory at Whiting, Ind.

Proell, a University of Chicago graduate, joined the company in 1938 as a research chemist at Whiting. He has done extensive research on petrochemicals, particularly in the field of sulfur derivatives.

Dr. Weitkamp, who became associated with the company in 1937 as a research chemist, has carried out fundamental studies on the composition of fatty acids and the mechanism of hydrocarbon synthesis. He did his undergraduate work at Midland College, Fremont, Neb., and received a Ph.D. from the University of Nebraska.

Mann Elected President Cities Service Refining

Louis D. Mann was elected president of Cities Service Refining Corporation, succeeding Burl S. Watson who recently became chairman of the executive committee. Mann, a veteran of the organization, joined as a chemist in 1917 after receiving his B.S. degree from Union College. He advanced rapidly through various refinery positions and during World War II was manager of the Cities Service Defense Corporation, Maumelle Ordnance Works at Little Rock, Ark. Since 1946 he has been vice president and general manager of Cities Service Refining Corporation which operates the giant Tutwiler Refinery at Lake Charles, La.

Mann

Marshall Plan Countries Approach Refining Goal

Marshall Plan countries will soon reach a production level where they will be self-sufficient in oil products according to an opinion expressed by the Oil Committee of the Organization for European Economic Cooperation in its second report on the oil refinery expansion program. By 1952 refinery output will supply about 59 million metric tons of products toward the 61 million tons required for inland consumption according to the published estimate.

Bunker requirements, supplies to overseas territories and exports to nations not participating in the Marshall Plan are not covered by the "self-sufficient" aspect of the report. About 11.4 million tons of petroleum products will have to be imported to cover these requirements.

Within the next two years the committee expects refinery output in Europe to increase to about 65 million tons, a planned hike to meet demands which rose 18 percent between 1949 and 1951. To date, ECA has financed, in whole or in part, twelve refineries, involving $35 million in aid. ECA has also supplied, through last April, a total of more than $1.2 billion worth of petroleum and petroleum equipment.

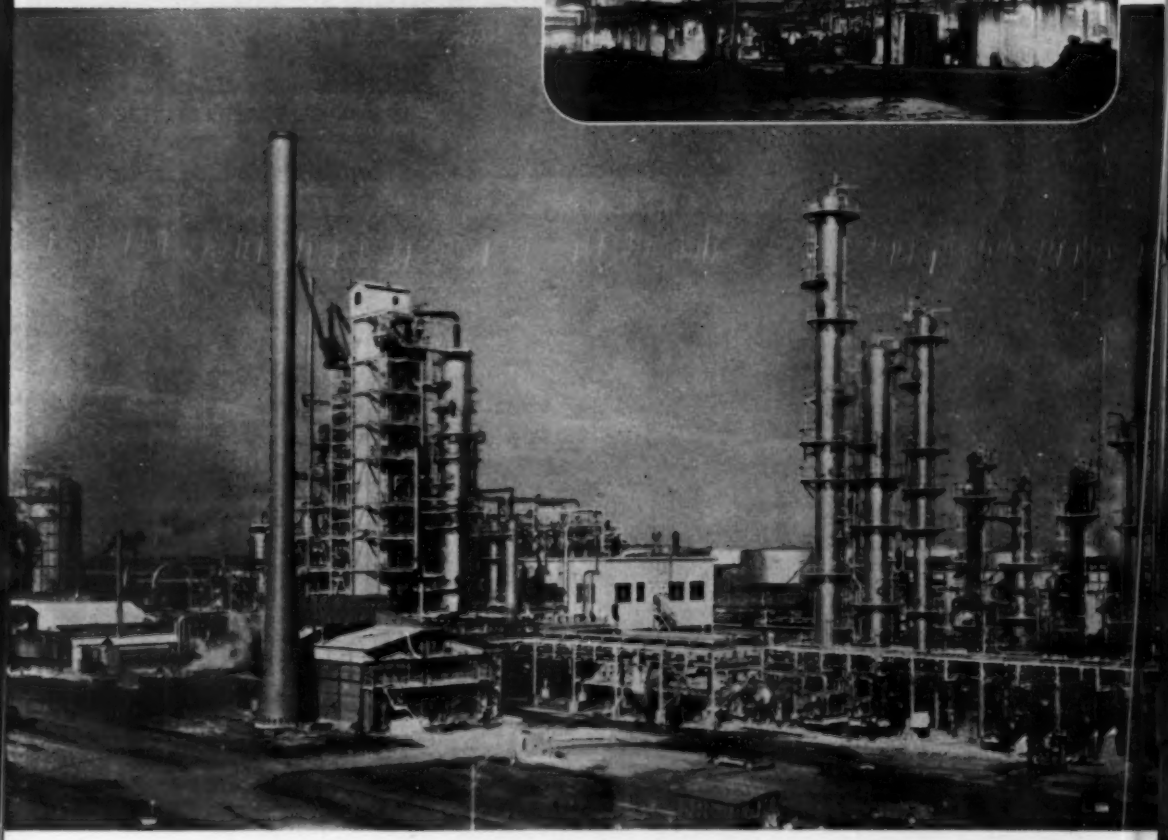
Particulars Sought About Synthetic Fuel Projects

Action on Secretary Chapman's $455 million request for the establishment of a synthetic liquid fuels plant may have been stalled temporarily by Defense Production Administrator Fleischman's demand for a "bill of particulars" supporting Chapman's argument for a 30,000-barrel coal hydrogenation plant and a 10,000-barrel shale oil facility. It is hinted that such a bill of particulars may be beyond the Department's ability to fill at this time. Fleischman's request evidently required data and detailed analysis on the comparative costs per gallon of liquid fuels from petroleum and from coal and shale.

Deputy PAD Bruce K. Brown has refused to comment on Chapman's proposal, but it is assumed he is still opposed to production which requires 4.5 tons of a solid fuel to make one ton of

NEW CAT CRACKER BY McKEE

● Engineering and construction of this compact new Catalytic Cracker and its integrated facilities were recently completed by Arthur G. McKee & Company for Shell Oil Company of Canada, Limited.



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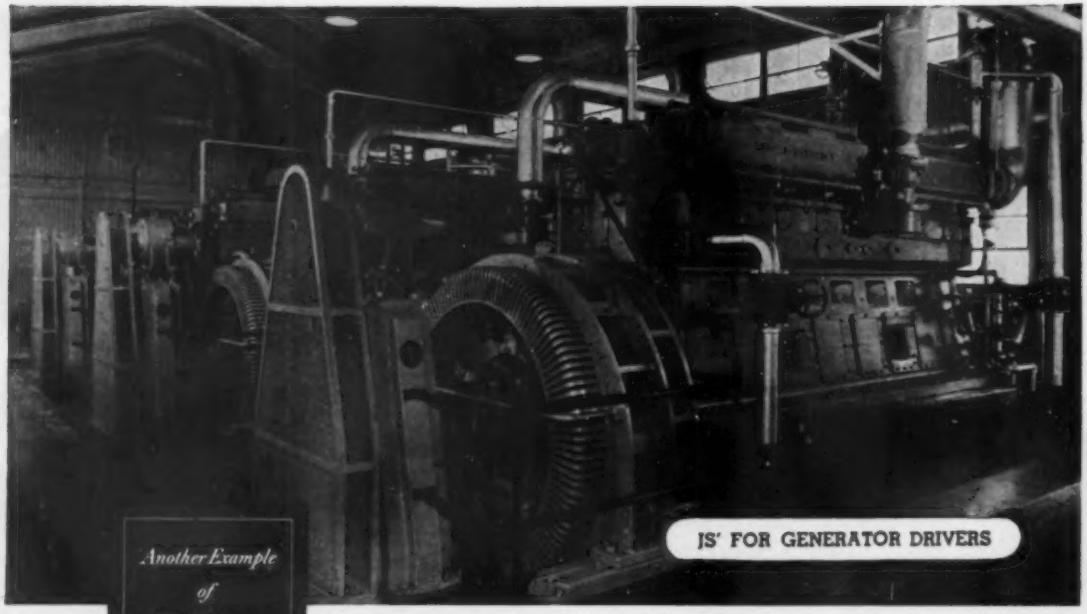

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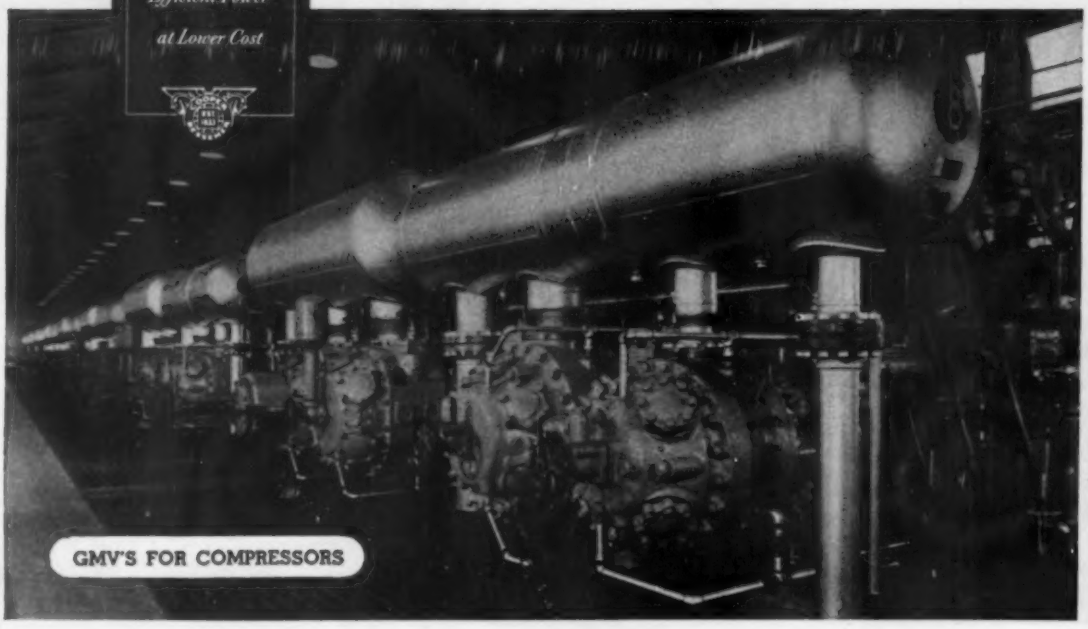

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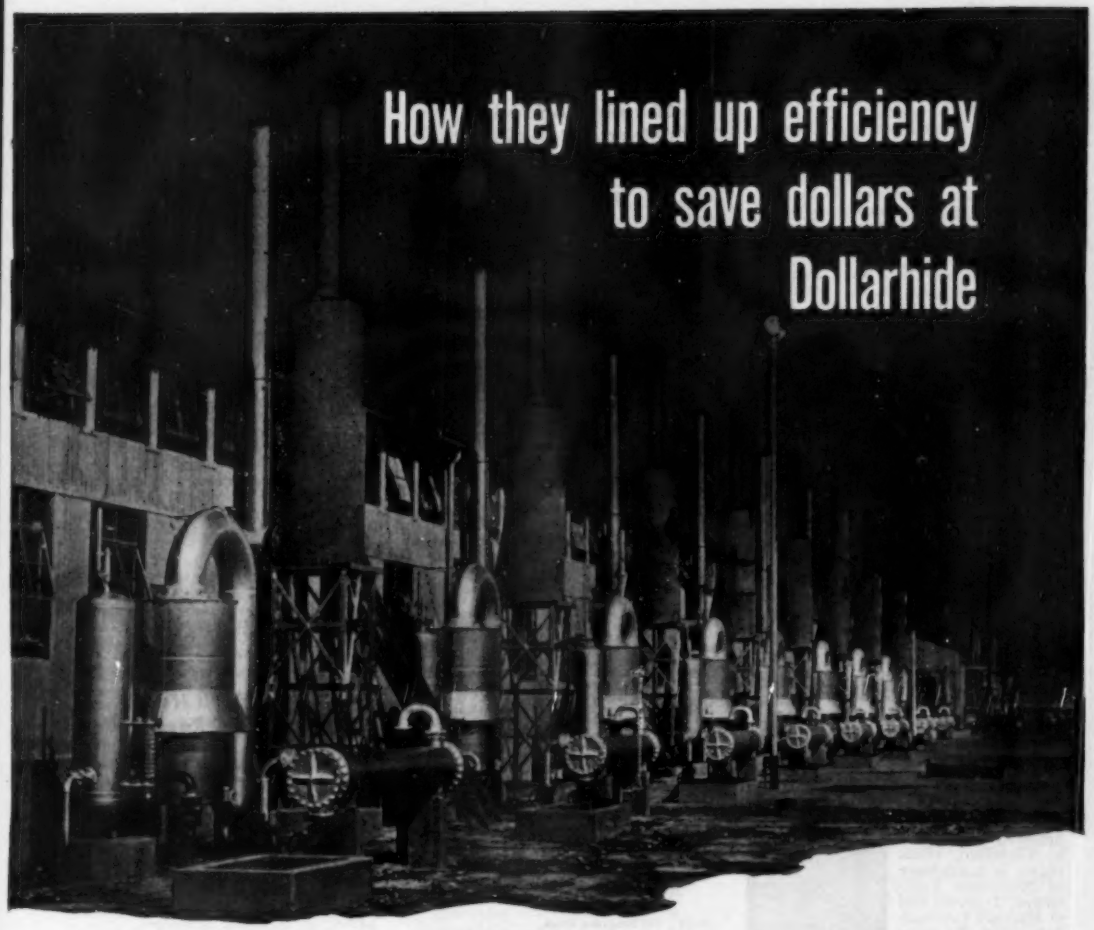
New York Washington, D. C. Bradford, Pa. Parkersburg, W. Va.
San Francisco, Cal. Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle, Wash.



How they lined up efficiency to save dollars at Dollarhide

• The Dollarhide Plant, operated by The Pure Oil Company, is a "beautiful" plant, say those who have seen it—one of the newest, most efficient gasoline plants today.

Those Cooper-Bessemer GMV compressors and JS gas engines do make an impressive line-up, but more important, they *line up* a combination of reliability and efficiency you just can't beat. That's why they're on this and so many other important jobs.

The compressor line consists of eight 10-cylinder GMV's, all supercharged, for a total of 10,040 compressor hp (at 3150' elevation). Each is a 3-stage compressor, zero suction to 650 lbs. discharge, with automatic speed control and manually operated unloading. This minimizes maintenance and attention without risking a suction pressure drop that would allow air to enter the sour gas stream.

There are modern Cooper-Bessemer V-angles . . . GMV's, GMX's and GMW's from 220 to 3,000 bhp . . . that will efficiently meet your needs no matter how exacting or complex.

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Tulsa Shreveport St. Louis Los Angeles Chicago Caracas, Venezuela

The MONTH...

synthetic liquid fuel. He testified in 1948 that he opposed coal synthesis as being wasteful of resources.

The money requested by Chapman was to guarantee private promoters against loss in constructing and operating a hydrogenation plant and a smaller shale oil plant, by insuring, to the sum of $400 million, government purchase of the product. His argument in favor of the plant is that it would consume less scarce steel than a similar petroleum project. This assertion was reportedly testified to by Dr. W. C. Schroeder, Interior Department synthetic liquid fuels chief, and Interior Undersecretary Richard Searles, before the House Commerce Committee.

The hearing brought out the facts that the Army Engineer Corps has been making surveys for the Bureau of Mines on the availability of coal, shale and natural gas deposits which could be used in the projected synthetics program. The Bureau of Mines is reported to have begun testing coal from southern Illinois at its Missouri test plant.

One seeming result of the controversy was the replacement of Dr. James Boyd as head of the Defense Minerals Administration by Dr. Schroeder. Dr. Boyd questioned the figures quoted by Chapman to show that synthetic fuels could be produced competitively with those from natural petroleum.

Howe Heads 1952 ASME Symposium: High Pressure

W. H. Howe, chief engineer of The Foxboro Company, will head the general arrangements committee for the Symposium on High Pressure to be sponsored by ASME, September 8-12, 1952, at Cleveland, Ohio. Howe is a graduate of Worcester Polytechnic Institute and of Harvard Graduate School of Business Administration. He was formerly associated with the Atlantic Precision Instrument Company, specializing on capacity systems for continuous measurement of paper, rubber, etc. Interested authors have been invited to submit an abstract of their proposed papers to Howe before May 1, 1952.

Howe

AIChE Annual Meeting Next Month in Galveston

Over 400 delegates to the Sixth Annual Technical Meeting of the South Texas Section of the American Institute of Chemical Engineers are expected to convene at the Hotel Galvez in Galveston on October 19. The all-day technical meetings will include papers on catalytic reforming, heat transfer and waste disposal; an industrial exhibit will round out the program.

Francis J. Curtis, vice president of Monsanto Chemical Company will be a speaker at the banquet to be held at the close of the technical sessions. General chairman of the meeting is Dr. W. B. Franklin, Humble Oil and Refining Company, and J. A. Lee, Southwest editor of Chemical Engineering, is developing the technical program.

Two Chemists Added to Sun's Marcus Hook Plant

Two chemists who recently completed their doctorate work at Pennsylvania State College, joined the staff of Sun Oil Company's Research and Development Department at Marcus Hook, Pa. William K. Conn, Philadelphia, specialized in organic chemistry; J. West Loveland, Buffalo, N. Y., specialized in physical chemistry.

THE OIL MAN'S CALENDAR

SEPT. 10-13	Int. Congress of Pure & Applied Chemistry, 12th Conference, N. Y., Hotel Statler.
10-14	Instrument Society of America, Sixth National Instrument Conference and Exhibit, Houston, Sam Houston Coliseum.
11-13	International Discussion on Postwar Heat Transfer Development with ASME Administrative Coordinator, London.
12-14	National Petroleum Association, Atlantic City, N.J., Hotel Traymore.
13-14	Texas A. & M. Instrumentation Symposium, Houston, Sam Houston Coliseum.
14-15	Int. Union of Pure & Applied Chemistry, 16th Conference, Washington, D.C., Hotel Statler.
16-19	American Institute of Chemical Engineers, Regional Meeting, Rochester, N.Y., Sheraton Hotel.
20-21	WPRA Regional, Casper, Wyo., Hotel Henning.
24-26	ASME, Sixth Petroleum Mechanical Engineering Conference, Tulsa, Mayo Hotel.
25-28	American Society of Mechanical Engineers, Fall. Minneapolis, Minn., Hotel Radisson.
OCT. 4- 5	California Natural Gasoline Association, 26th Annual. Los Angeles, Ambassador Hotel.
8- 9	Texas Mid-Continent Oil & Gas Association, Annual. Beaumont, Texas, Hotel Beaumont.
8-10	The American Oil Chemists' Society, Fall. Chicago. Edgewater Beach Hotel.
8-12	National Safety Council, 39th National Safety Congress and Exposition, Chicago. Stevens Hotel.
14-20	Oil Progress Week.
15-17	American Gas Association, Annual. St. Louis, Kiel Auditorium.
15-19	National Metal Congress & Exposition, Detroit, Mich.
18-20	National Association of Corrosion Engineers, South Central Region. Corpus Christi, Texas.
19	NGAA, Regional, Tyler, Texas, Blackstone Hotel.
22-24	American Standards Assn., Annual. New York, Waldorf-Astoria Hotel.
29-31	National Lubricating Grease Institute, Annual. Chicago, Edgewater Beach Hotel.
31 to Nov. 1	National Transportation Meeting, Chicago, Knickerbocker Hotel.
NOV. 3- 8	Oil Industry Information Committee, Chicago, Stevens Hotel.
5- 8	American Petroleum Institute, Annual Convention, Chicago. Stevens Hotel.
22-23	Independent Petroleum Assoc. of America, Annual, Houston, Shamrock Hotel.
25-30	American Society Mechanical Engineers, Annual Meet, Atlantic City, Chalfonte-Haddon Hall.
26 to Dec. 1	Exposition of Chemical Industries, New York, Grand Central Palace.
DEC. 2- 5	American Institute Chemical Engineers, Atlantic City, Chalfonte-Haddon Hall.
7	NGAA Regional, Amarillo, Herring Hotel.
26-31	American Assn. for the Advancement of Science, Annual, Philadelphia, The Bellevue-Stratford.

Increase in Oil Company Net Incomes Are Shown

Surveying 30 oil companies, representing two-thirds of the domestic oil industry, Chase National Bank of New York reported that during the first six months of 1951 the companies had chalked up a net income of $999 million. This represents a gain of over 41 percent of the like 1950 period. Their combined gross operating income for the period showed a 23.6 percent increase over the same period of 1950. Cash dividends declared by the group amounted to $349 million, for a gain of 27.8 percent over the 1950 figures. The survey group estimated that a record gross operating income of $18 billion may be recorded this year to compare with $15.268 billion last year.

The high figures for 1951 are attributed to a 20 percent rise in crude oil production, a 13 percent rise in demand for all oils, and a 12 percent hike in domestic prices of refined products.

Because of extensive expansion and building programs, capital expenditures for property, plant and equipment will be higher than the $1894 million spent last year and most of this investment will be paid for out of earnings, the survey concluded.

Union Oil Company of California showed a 149.9 percent increase in net earnings to lead all companies surveyed in percentage increase. The Standard Oil Company (Ohio) reported the smallest increase of all companies reporting.

Dr. Condon Will Head Corning Glass Research

Dr. Edward U. Condon, noted nuclear physicist, has been appointed director of research and development of Corning Glass Works. Dr. Condon's resignation as director of the National Bureau of Standards in Washington, D. C., was recently accepted by President Truman.

Dr. Jesse T. Littleton will become general technical advisor for the firm and will be available to all departments of the company and its subsidiaries for advice on technical problems.

Dr. Condon was appointed Director of the National Bureau of Standards by President Truman in November, 1945, and simultaneously began giving full time service as scientific advisor to the Special Committee on Atomic Energy of the U. S. Senate. In the summer of 1946 he attended the Naval atomic bomb tests at Bikini as a member of the President's Evaluation Board.

Eichelberger to Speak

Lt. Gen. Robert L. Eichelberger, commander of the U. S. 8th Army during World War II, will be the principal speaker at the annual Northeastern District meeting of the Liquefied Petroleum Gas Association. The event is scheduled for Thursday, October 11, at the Hotel Statler, New York City.

Petroleum Wax Gains

An increase over 1950 figures of 5.8 million pounds of petroleum wax held by U. S. refining companies was reported by the Bureau of Mines in a monthly petroleum statement for June. The report also states a 7000 barrel decline on June 30 in total stocks of lubricating oils. The total on hand was 8,444,000 barrels. Other declines were

reported for microcrystalline wax with an inventory of 840,000 pounds. The same total for fully refined grades were offset by increased stocks of "other" waxes, principally crude scale.

The 168,280,000 pounds of wax reported for June 30 were the highest total stocks since the end of 1931 when inventories totaled 180,843,000 pounds; this is a gain of approximately 10 million pounds above inventories on June 30, 1950.

Petroleum Classified With "Insufficient" Minerals

A Bureau of Mines report grouping petroleum among minerals not in sufficient production to meet demand, has been strongly endorsed by Secretary of the Interior Chapman, in apparent support of his plan for early government development of synthetic liquid fuels. According to the Bureau, only 9 of 38 important metals and minerals will be produced in sufficient quantities to meet or exceed consumption demands in 1951. These are natural gas, sulfur, anthracite coal, bituminous coal, lignite, molybdenum, phosphate rock, salt, helium and magnesium.

Petroleum is placed in a 90 to 100 percent "self-sufficiency" category. The term defined by the Bureau means, "ratio of domestic mine production to U. S. consumption."

Big Catalyst Plant Set for Lake Charles, La.

As part of industry's nation-wide effort to meet expanding defense and civilian requirements for petroleum The Davison Chemical Corporation will erect a large catalyst plant on the Calcasieu River six miles south of Lake Charles, La. Project is estimated to cost $7 million and is scheduled to be in operation early in 1953. It will produce enough synthetic fluid petroleum cracking catalyst to process nearly 600,000 barrels of petroleum stocks per day based on average refinery use of cracking catalysts.

Day & Zimmerman, Inc., of Philadelphia, are engineers of the project and Consolidated Engineering Company of Baltimore, are general contractors.

Heads Auto Research of Pan American Refining

William Kaplan's appointment as director of the automotive research laboratory for Pan American Refining Corporation, became effective this month. He will reside in Baltimore, Md., where the automotive laboratory is located.

Kaplan received his degree in chemical engineering in 1927 from M.I.T. and went right to work in the oil industry. In 1941 he was employed by the research department of Pan American Refining Corporation. His latest position in the Texas City laboratory was as section chief in charge of technical service.

Erratum

Photographs of the Eurotank (page 112) and Grangemouth (page 118) refineries in this issue of PETROLEUM REFINER were inadvertently switched. Photo at bottom of page 118 labeled Grangemouth actually is a general view of the Eurotank construction and the photo at top of page 112 is the Grangemouth tank farm with catalytic construction in left foreground.

Whiteford

Berg

B-A Elects Whiteford Director; Berg President

The British American Oil Company Limited of Toronto recently elected William Kepler Whiteford chairman of the board of directors, and named Ole Berg, Jr., president of the company.

Whiteford, a native of Los Angeles, has been president of the company since 1943. After graduation from Stanford University he spent several years in the drilling and production end of the petroleum industry, and then moved on into administrative capacities for a large independent company in California. He joined The British American Oil Producing Company as executive vice president in 1935, and was appointed to the same office for The British Oil Company Limited in 1942.

Berg, also a Californian, was educated at Oakland, Calif., and entered the petroleum field in 1921. With the Union Oil Company for 27 years, he rose from office clerk to manager of marketing. In 1945 he was appointed vice president and manager of general sales; he was also vice president and director of the Union Oil Company of Canada. He joined B-A in 1948 as vice president and assistant to the president, served briefly as vice president of marketing, and then was appointed president last month.

PAD Asks U. S. Refiners For Fullest Cooperation

"Unstinting cooperation" was requested of the refining industry by T. L. Apjohn, assistant director of PAD's Refining Division as he called for effort to meet increased demands for high-octane aviation gasoline. In April, said Apjohn, the refining industry seemed to be in a good position to meet all short-term demands for aviation gasoline, but by July the situation was drastically changed because of the necessity of airforce missions abroad and the shortening of supplies by the shutdown of the Abadan refinery.

"Extraordinary measures" have already been taken by the industry, he said and pointed to the use of selective polymer as alkylation feed, the shipment of alkylation stocks from one refinery to spare alkylation capacity in another, as well as rehabilitated and newly constructed facilities which will be coming on stream in future months.

Jet fuel requirements reportedly do not pose supply problems at the present time because specialized processing equipment is not essential for jet fuel and because less jet fuel has been needed. However, Apjohn warned that jet requirements would be great in the case of an all-out emergency, but could be met, if basic refining capacity is increased on schedule.

The MONTH...

Prentis Named Director

H. W. Prentis Jr., chairman of the board of directors of the Armstrong Cork Company, has been elected to the board of directors of The Atlantic Refining Company. The election of Prentis fills the vacancy on Atlantic's board caused by the recent death of A. A. Garrabrant.

Sears Rejoins Phillips

Robert N. Sears, who recently returned to Bartlesville, Okla., from Washington, D. C., where he was on loan to PAD, has been appointed assistant to the executive staff of Phillips Petroleum Company. Sears will assume special assignments given him by the executive branch.

Sears was assistant to the president of Wasatch Oil Company in Salt Lake City, Utah, when it was purchased by Phillips in 1947. He also served as chairman of the Wasatch operating committee. Joining the economics department of Phillips in 1948 he worked on

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1950:									
January 20	4,956	5,470	348,411	18,303	124,270	7,303	66,337	8,389	57,036
February 28	5,000	5,277	343,598	17,708	133,888	6,990	56,068	7,856	48,942
March 25	4,948	5,469	344,227	17,939	135,606	6,870	49,877	8,171	42,546
April 29	5,014	5,314	344,744	18,038	128,655	6,531	36,580	7,272	39,280
May 27	5,118	5,591	340,842	18,704	122,757	7,201	40,607	7,421	39,308
June 24	5,355	5,636	340,762	19,626	115,036	6,966	50,580	7,461	41,291
July 29	5,522	5,870	340,236	19,981	109,076	7,266	61,437	7,870	42,263
August 26	5,699	6,197	336,934	20,263	105,793	7,550	65,841	8,543	41,607
September 30	5,903	6,051	341,631	19,624	104,353	8,490	76,734	8,306	42,220
October 28	5,895	6,051	344,305	19,578	105,062	8,259	84,057	8,440	44,310
November 25	5,888	6,236	344,497	19,847	109,424	8,591	86,768	8,470	45,566
December 23	5,763	6,189	350,799	20,075	112,631	9,436	73,373	8,715	39,914
1951:									
January 27	6,066	6,493	344,230	21,106	126,261	9,854	56,997	9,905	40,378
February 24	5,954	6,524	337,204	20,815	136,870	10,545	48,794	9,471	38,995
March 31	6,041	6,381	328,956	20,396	142,198	9,366	43,170	9,147	37,282
April 28	6,154	6,236	342,479	19,876	137,474	8,061	45,859	8,747	36,080
May 26	6,163	6,430	346,400	21,102	130,819	8,580	51,344	9,046	37,365
June 30	6,181	6,595	347,299	21,666	126,844	8,543	65,700	9,036	41,097
July 28	6,205	6,396	251,203	21,539	121,186	8,174	76,938	8,858	44,957
August 25	6,230	6,500	252,257	21,502	115,934	8,761	85,543	8,763	46,783

The MONTH . . .

many special assignments, acting as Phillips representative in American Independent Oil Company matters. Sears holds a master's degree in business administration from the Harvard Graduate Business School.

CRC Engineering Opens Houston Headquarters

Engineering design services for oil and gas pipe line operators will be offered by CRC Engineering Company, a newly organized firm with headquarters in Houston. Partners of the new firm are H. E. Fisher, A. S. Crutcher, Gene Rolfs and Jim Cummings. Fisher, who recently resigned as chief engineer of Standard Oil Company (Indiana), has been associated with the engineering design and construction of pipe lines for 20 years. Crutcher, Rolfs and Cummings have operated for more than 18 years in the development manufacture and supply of equipment for the pipe line industry.

Fisher

Kobe Advises Brazilian Petroleum Council

Dr. Kenneth A. Kobe, professor of chemical engineering at the University of Texas, has recently returned from a month's visit to Rio de Janeiro, where he served as an educational advisor to the Consuelo Nacional do Petroleo.

Dr. Kobe reported that the Council is interested in employing Brazilian graduates in industrial chemistry and chemical engineering as refinery engineers in the Bahia refinery and the contemplated Cubatao refinery. On the basis of Kobe's recommendations, a one-year training program will be instituted in conjunction with the University of Brazil. The training program will include courses in unit operations and petroleum technology with special emphasis given to process design.

Dr. Kobe will continue to serve as an advisor and is presently seeking American instructors who are qualified to teach in such a program.

Personnel Changes Listed By Phillips Chemical

Five personnel changes in Phillips Chemical Company became effective September 1.

J. W. Barber, superintendent of the company's Philblack Plants at Borger, Texas, will be assigned to the Philblack sales division as rubber service engineer. Barber recently returned from an extended assignment in England, in connection with the start-up of operations of the Philblack, Ltd., plant.

Succeeding Barber as superintendent of Philblack Plants will be A. J. Head, who has been acting superintendent during Barber's absence.

Austin Morgan, services superintendent at Plains Plant, Borger, will be assigned to Bartlesville to fill the newly-created position of assistant chief mechanical engineer. H. H. Stoelzle, acting mechanical and maintenance superintendent at Plains Plant, will succeed Morgan as service superintendent.

M. L. Studebaker, consulting chemical engineer in the process engineering division, will be assigned to the Philblack sales division as technical service engineer, with headquarters in Arkron, Ohio.

Bolt and Hart Promoted At Whiting Research Lab

John A. Bolt was promoted to division director of light oils and special products in the Standard Oil Company (Indiana) research laboratory at Whiting. Formerly assistant superintendent of technical service, he succeeds Dr. Philip C. White. Dr. White left Standard (Indiana) to become manager of research and development for Pan American Refining Corporation at Texas City.

Bolt joined Standard in 1930 as a chemist at the Whiting laboratory and became a group leader in 1944 and assistant superintendent of technical service in 1947. Bolt holds degrees from Calvin College, Grand Rapids, Mich., and from the University of Michigan.

H. M. Hart, formerly a group leader at the Sugar Creek, Mo., refinery, has been promoted and transferred to Whiting as assistant superintendent of technical service. Hart joined Standard (Indiana) in 1940 as a chemical engineer following graduation from Montana State college.

Continental Names Kircher Manager of Petrochemicals

Expansion of Continental Oil Company's petrolchemical department has resulted in the appointment of Dr. John E. Kircher, of Chicago, as manager of the expanded unit. He will make his headquarters in Continental Oil's executive offices in Houston. Dr. Kircher also becomes vice president and a director of Sharples-Continental Corporation, Baltimore, manufacturers of base products for detergents; vice president and director of Petroleum Chemicals, Inc.; and a director of Continental Oil Black Corporation, which is constructing a $1.5 million plant near Lake Charles, La.

Kircher

Dr. Kircher is best known for his specialization in the synthetic detergent field, particularly for research in the development of synthetic rubber. A Missourian, he holds a B.A. degree from Culver-Stockton College, Canton, Mo., a Ph.D. degree in chemistry from the University of Missouri. He was appointed from a position as director of development for the Stephan Chemical Company, Chicago.

Lutz Named by PAD

Alton S. Lutz has been appointed assistant to the director of PAD's Natural Gas Division in charge of problems relating to distribution of LP-Gas. From 1924 to 1951 he served Propane Corporation of Erie, Pa., as vice president and general sales manager.

Fluor Creates Defense Projects Engineering Unit

The Fluor Corporation, Ltd., Los Angeles engineers and constructors, have created a new Defense Projects Engineering department and named M. R. Born to head the unit. Born joined the company from Arnold Research Organization, Inc., of St. Louis, and Tullahoma, Tenn., where he served as chief of engine test facilities. A graduate of Stanford University with degrees in mechanical and electrical engineering, Born's job will be "to coordinate Fluor's various contracts, particularly the military." Born has had wide experience in steel and oil industries as well as in aviation development circles.

Born

J. E. Swearingen to Head Production for Indiana

J. E. Swearingen has been appointed general manager of production of the Standard Oil Company (Indiana) at Chicago. Previously he had been a director and assistant to the executive vice president of Stanolind Oil and Gas Company at Tulsa, Okla.

Swearingen joined Standard Oil in 1939 as a chemical engineer in the Research Department at Whiting.

National Constructors Put Fluor on Executive Group

J. S. Fluor, executive vice president of The Fluor Corporation, Ltd., Los Angeles, has been elected to the executive committee of the National Constructors Association, an organization of firms engaging in engineering and building of oil refineries, steel mills, and chemical plants. He will serve until 1953.

Safety Men Visit Martinez

Twelve distinguished European safety experts studied modern accident prevention methods of the petroleum industry during a one-day visit to Shell Oil Company's Martinez Refinery, under the guidance of the California Department of Industrial Relations. The foreign safety engineers represented Sweden, Norway, Denmark and Turkey and are making a two-month tour of American industries under the sponsorship of the Economic Cooperation Administration and the Department of Labor.

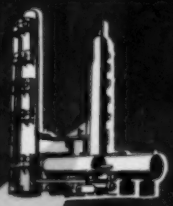
AEC Contracts Signed

American Cyanamid Company has signed two non-profit contracts with the Atomic Energy Commission, one calling for extensive research to find new ways of recovering uranium from various ores and the other for operation of a plant to recover nuclear fuel from used reactor fuel elements.

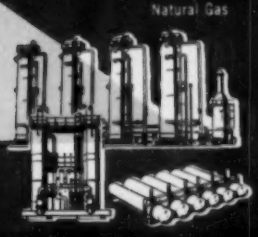
Under terms of the second contract, the company will operate a chemical processing plant at the AEC's reactor testing station near Idaho Falls, Idaho. About 70 percent of the staff, now being recruited, will be scientists and technicians. F. Allen Hall was named manager of the Idaho Falls plant.

PETROLEUM
REFINER
1951 PROCESS SECTION

Power


Chemical

Outstanding
in
Industry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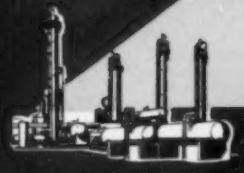
Petroleum

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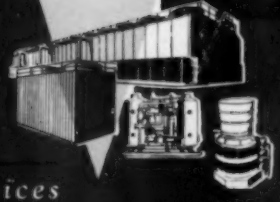
Equipment

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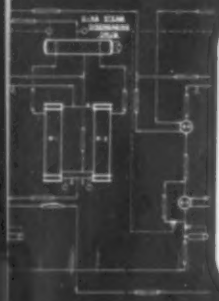
J. F. Pritchard & Co. is staffed by a group of thoroughly trained and experienced engineers, all with intensive knowledge of various processing industries and the specific unit operations involved in each. Our wealth of technical "know-how" and experience gained from numerous operating plants which we have designed, engineered and constructed during the past quarter of a century is your assurance of our *outstanding ability* to serve the industry.



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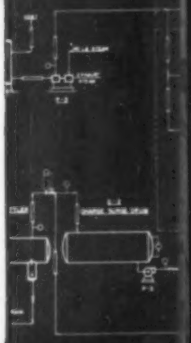
Pritchard-built plants are *outstanding* for their low cost, operating efficiency and production to the *exacting* quality standards set by the customer. Superiority of product . . . maximum plant efficiency . . . ease of operation . . . longer periods of continuous production with freedom from maintenance troubles . . . these are the things for which Pritchard-built plants are known in industry today.

Outstanding Services...



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Recent Trends in Refining Processing

WITHIN the past year important trends have occurred in refining processing which are the result of a changing petroleum product market. There has been, of course, an increased demand for all petroleum products. However, special emphasis is directed toward fuels for internal combustion engines. In the automotive field there is not only an over-all increase in demand, but the octane requirements are higher than ever before. Substantially the same trend is occurring also in the aviation field, where there is a growing demand for the highest octane aviation gasoline yet produced. In an entirely different direction, there is a sharp increase in the demand for chemical intermediates from petroleum. This includes, especially, benzene and other aromatics, and ethylene. Thus recent trends in refining processing are shifting further toward the production of highly specialized products with very specific properties. In the face of such market changes it is not surprising that there has been much activity in the development of new refining processes, and in the improvement of older processes.

In the motor gasoline field the demand for larger production has been coupled with requirements for higher octane numbers. Throughout the years there has been a continuous increase in octane demands resulting from the continually-increasing compression ratios built into new automobiles. Within the last year, however, octane requirements of premium fuels have risen so high that it has been necessary for many refiners to re-evaluate completely their over-all refining operations.

In order to meet the increased demands of the motor fuel market, catalytic cracking is of high current interest. Catalytic cracking is further displacing thermal cracking, because the catalytic processes are more specific and produce greater yields of higher quality products. Since VJ-day, approximately 800,000 barrels per day of new catalytic cracking capacity of all types has been or is being installed. This does not include the modernization of existing units.

The improved catalytic cracking processes all utilize either a moving catalyst bed or the fluid technique, and there are no new fixed-bed units being built. Although no fundamentally new cracking processes have appeared, there has been significant improvements in existing processes during the past year. These developments have been along the lines of general simplifications of the design, equipment, and piping requirements. These simplifications have led to lower investment costs, and the economic design of small catalytic cracking units for the small refiner. Particular attention has been paid to design improvements to lower maintenance requirements in order that the new units may operate at high on-stream factors. This of course has contributed to lower operating costs and higher overall production.

With the higher octane requirements of motor fuel, a great deal of attention has been focused recently on the straight-run blending stocks. It has always been customary for refiners to blend large quantities of virgin naphthas into motor gasolines. These straight-run fractions contain a considerable quantity of naphthenes and straight-chain aliphatics of low octane number, but with the addition of higher quality blending fractions and lead, the normal demands for motor fuel quality have been met. However, with enlarged demand for motor gasoline of higher knock ratings, it is becoming increasingly difficult to utilize these virgin naphthas.

In order to meet the problem of upgrading the straight-run fractions a group of new catalytic reforming processes have been developed, and a substantial number of plants are being built. Thermal reforming, which has been used previously for this purpose, is not favored now because of the low yield and quality of the product. All the new reforming processes are catalytic and continuous. The catalysts employed are highly selective in the promotion of the specific types of reactions desired. Because of this it is possible to operate under conditions of high severity without excessive gas production. As a result the octane-yield relationships obtained are exceptional.

New trends in aviation gasoline include sharp increases in both quantity and quality. Although the demand for aviation gasoline has not been great since World War II, there is at present a

potential sharp increase in the interest of national preparedness. This is accompanied by a considerable increase in octane requirements. Whereas a few years ago a substantial portion of aviation fuel was below 100 octane, the current demand is based on a minimum quality of 100/130 grade. Furthermore, it is expected that all conventionally-powered combat aircraft will require the 115/145 grade.

With the increase in octane requirements of aviation gasoline, alkylation is again becoming one of the key processes for the production of aviation fuels. In order to produce 100/130 grade fuel, it has been found necessary to blend in approximately one-third alkylate. With grade 115/145 fuel, the amount of alkylate required is two-thirds or more, and must consist substantially of butylene alkylates.

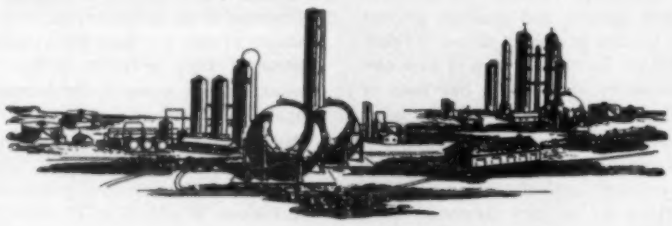
As a result, there is a revived interest in alkylation. A number of shut-down wartime alkylation units have been reactivated, other idle plants are planning startups, and new alkylation units are being built. Fundamentally, the alkylation processes have not changed since the war. The principal processes are still based on sulfuric acid and hydrofluoric acid as catalysts. However, there have been numerous and distinct improvements in design and processing. These developments have resulted in simpler plants, lower investment requirements, and lower operating costs.

At the present time there appears to be sufficient feedstocks from conventional sources for alkylation. Butylenes and other olefins are available from catalytic cracking, and isobutane is available from casing head gas. Thus there does not appear to be much current interest in the isomerization of normal butane. However, if the demand for alkylate increases to anywhere near previous wartime levels, it no doubt will be found necessary to resort to isomerization to augment the supply of feedstock.

Another trend in the petroleum processing picture is the skyrocketing demand for chemical building blocks from petroleum. This is particularly true of benzene and other aromatics. There is currently a greatly-increased demand for benzene for the manufacture of styrene, phenol, nylon, aniline, and other chemicals. At the same time the supply of benzene from conventional coking operations has no hope of keeping pace. As a result there is a real need for benzene and other aromatics from new sources, and it is only natural that petroleum is looked upon as one of the best raw materials. Since it is possible to produce these aromatics by the catalytic reforming of naphthas, followed by separation and purification by extractive distillation or adsorption processes, there is currently a great deal of activity in these fields.

For ethylene, also, the chemical industry looks to petroleum as a raw material. With the greatly increased demand for ethylene for alcohol, ethylene glycol, styrene, polyethylene, and others, the supply of ethylene from normal refining operations is entirely insufficient. This supply currently is being augmented by cracking of ethane and propane, followed by separation and purification by absorption, adsorption, or low-temperature fractionation. A number of new plants are being built for the production of ethylene by these methods.

This September issue of PETROLEUM REFINER has been designated the 1951 Process Issue. Following an established practice, it is largely devoted to a treatment of oil industry processing schemes. As with the 1950 Process Issue, the present issue is devoted chiefly to reports on processes of high current interest—processes which have either been introduced or markedly improved within the past year or so. This includes alkylation, catalytic cracking, catalytic reforming, and aromatics and ethylene production. For a complete catalog of refining processes, the reader is referred to the September, 1949, issue of PETROLEUM REFINER.



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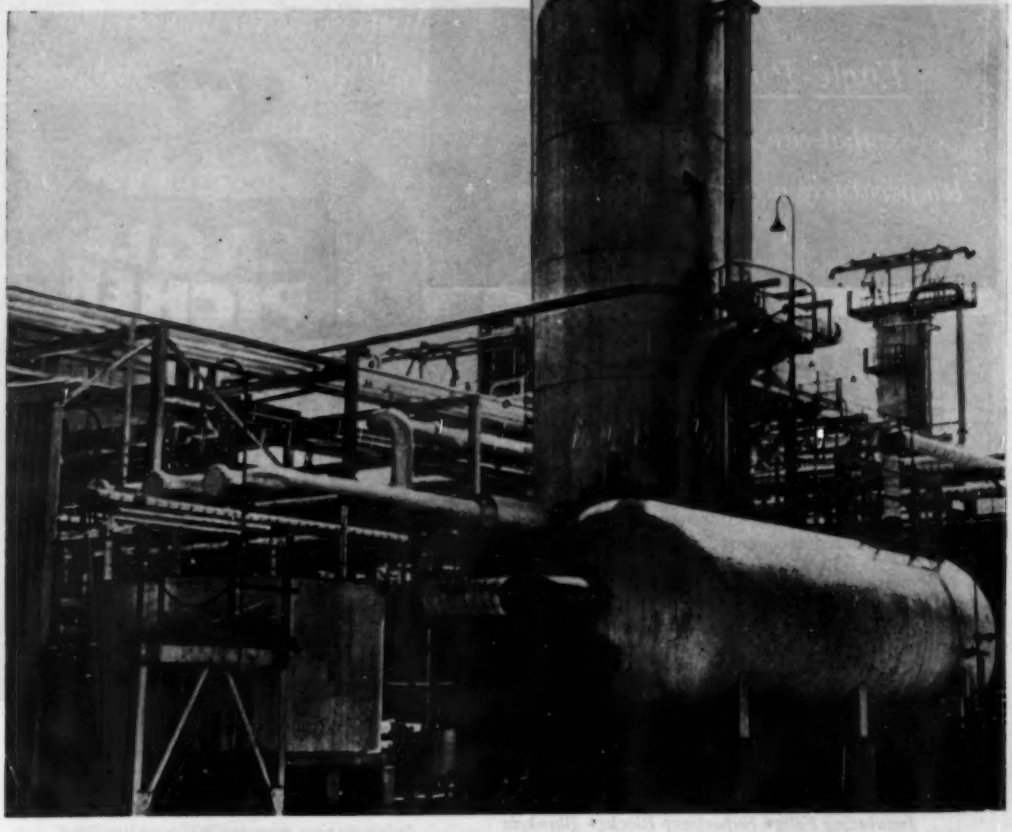

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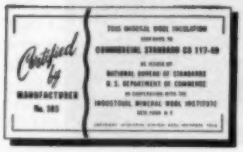

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ALKYLATION Commands New Interest from Refiners

WILLIAM L. BOLLES
Editorial Director, Petroleum Refiner

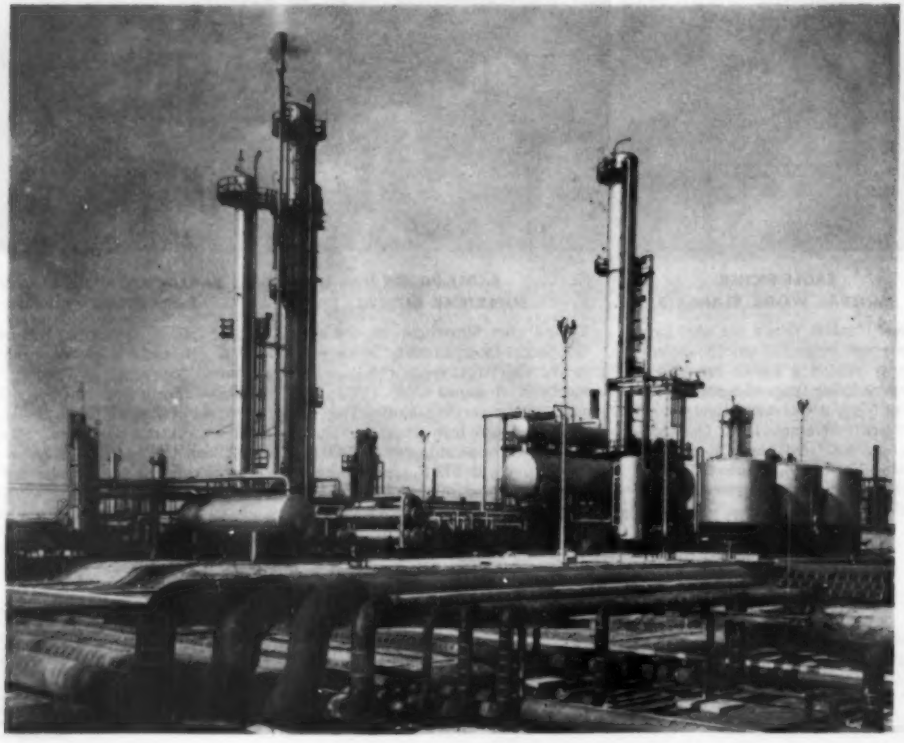
THE process of alkylation in the petroleum industry is now vitally linked with the production of aviation gasoline for conventional reciprocating engines. Before 1940 and the development of alkylation, there was practically no production of 100+ octane gasoline. However, the years 1940 through 1945 brought simultaneously the development of alkylation, and the demand for huge quantities of 100+ octane fuel. The production of this quantity of high quality fuel would have been practically impossible without alkylation, because it was found necessary to use about one-third alkylate in the blending of 100/130 grade fuel. However, following the war there was a sharp drop in the demand for high octane aviation fuel, and as a consequence most of the alkylation units were shut down. The production of aviation fuels during the period 1940 to 1950 is given in Table 1.[5]

TABLE 1
Aviation Gasoline Production, 1940-1950[5]
(THOUSANDS OF BARRELS)

YEAR	100 Octane and Above	Other Grades	Total
1940	643	4,727	5,370
1941	.....	.....	21,110
1942	27,678	26,848	54,526
1943	62,044	44,179	106,223
1944	136,130	60,253	196,383
1945	124,215	28,180	152,395
1946	5,342	30,070	35,412
1947	17,823	17,429	35,252
1948	33,462	12,925	46,387
1949	35,215	11,891	47,106
1950	38,542	11,881	80,423

The quantity of production is not the whole story with regard to aviation gasoline. At the peak of production during World War II the combat grade aviation gasoline consisted of the 100/130 grade, and the military transport and commercial aviation used grade 91 and lower. At the end of the war, grade 115/145 became

The East's First Postwar Alkylation Unit—2000-Barrel-per-Day Plant of California Refining Company's Barber Refinery at Perth Amboy, N. J. (Courtesy, The M. W. Kellogg Company.)



DURING THE past year there has been a greatly renewed interest in alkylation for the production of high-octane aviation fuel. This is due to an increased demand for both both quantity and quality of aviation gasoline. During most of the last war, the highest quality fuel produced was grade 100/130, which could be produced with 25 to 35 percent alkylate. The years following the war saw a decline in the demand for alkylate and little incentive for spending money to improve the process or increase the capacity of existing plants. Now there is a new demand for grade 115/145 fuel for advanced engine designs, and it has been found that 70 to 80 percent alkylate is required in blends to reach the rich mixture rating. As a result, many of the old alkylation units have been reactivated. Further, there has been considerable activity in the improvement of alkylation processes. Given here is a survey of the alkylation processes as they appear today.

available. In 1946 the demand for grade 115/145 in relation to grade 100/130 was around 1 to 5. In 1947 it became approximately 1 to 3. Since most combat aircraft and many of the military transport planes require the 115/145 grade, it can be assumed that the proportion is much higher at present. In addition, some commercial aircraft operate on the 100/130 grade instead of the lower quality fuel used during the last war.[3]

With a huge defense program in the making, a new aviation gasoline situation has arisen. Not only must the refining industry be in position to supply enormous quantities of aviation fuel but it must be able to produce this fuel to specifications much higher than during World War II. Advances in aircraft engine design now make it necessary to supply a major portion of the aviation gasoline as 115/145 grade. The components of this grade are principally isopentane, alkylate and aromatics. The blending of 100/130 grade aviation fuel normally requires only from 25 to 35 percent alkylate, and considerable alkylate produced from olefins other than butylenes may be used. In the blending of 115/145 grade however, from 70 to 80 percent alkylate is required and this alkylate must be of high quality in order to meet the 145 rich mixture index. Such alkylate must be produced for the most part from butylenes, although as aromatic blending components become available more propylene and amylene alkylate may be worked into the blends. In all cases however, it is desirable to improve the octane rating of the alkylate so that it will make a greater quantity of finished blend.[3]

In analyzing the problem of improving aviation fuel quality it is interesting to observe that the types of hydrocarbons which are of the best quality are the isoparaffins such as isopentane and iso-octane and the aromatics such as toluene, xylene, ethylbenzene and cumene. Benzene is also high in octane rating but its use in aviation fuel is limited because of its high freezing point. The naphthenes, olefins and straight-chain paraffins which were present as the minor components of the 100/130 grade used in the last war are of poorer quality, decreasing approximately in the order named.[4]

With both increased quantity and quality of alkylate required to meet our defense demands it is evident that alkylation is going to take a very prominent position among the refining processes in the immediate future. A sizeable number of shutdown alkylation plants have already been reactivated, and it is reported that plans are in progress for the starting up of still more units.

Alkylation Processes

The alkylation processes of the petroleum industry involve the reaction of an isoparaffin (usually isobutane) with an olefin (usually butylene, propylene, or amylene) to produce a branched-chain paraffin hydrocarbon of higher molecular weight. The alkylate produced by the process boils in the gasoline range and has an ASTM clear octane number of 88-95, depending on the operating conditions and the character of the feed. Alkylates have excellent lead-susceptabilities and high heat-values, and are thus ideal blending components for aviation and motor gasolines.

In commercial processes the catalyst used is either sulfuric acid or hydrofluoric acid. Yields and quality of products with either catalyst are of the same order. The great bulk of the plants process isobutane and butylenes to produce an alkylate consisting of substantially C_8 branched-chain hydrocarbons, of which iso-octane is an example. Other feedstocks can and are being used, but the highest quality alkylate is obtained from BB feeds.

During the last war there developed a shortage of isobutane, and it became necessary to build isomerization plants for the conversion of normal to isobutane in order to satisfy the requirements for alkylation feedstocks. Today, with catalytic cracking as the backbone of refinery cracking, the isobutane production in many refineries may be adequate for alkylation without the necessity for extraneous stocks. Alkylation is particularly attractive where extraneous isobutane is available from casing-head gasoline at low cost. Here, the flexibility of catalytic cracking is a major factor in that the refiner can balance his operations (without affecting the prime product, gasoline) to provide high ratios of propylene and butylenes in the gaseous fraction; purchase cheap BB's and run his alkylation unit at a higher capacity.[5]

Although it has been reported that one butane isomerization plant has been started up, it is the general feeling of the industry that the normal supplies of isobutane will be adequate for alkylation requirements for some time to come. Hence there is little interest in butane isomerization at the present time.

Fundamentally, the alkylation processes have not changed since the war. The chemistry of the process is the same, and operating conditions and yields have not undergone any substantial modification. Nevertheless, there have been recent distinct and important developments in the alkylation processes along the lines of mechanical design and operation. Most of the present plants were built during the war, many of them before process development work was completed. As a result, there was a tendency to overdesign the units, and to provide auxiliary equipment to hedge against every foreseeable eventuality.

The new developments in alkylation units are being directed toward streamlining the plants. Unnecessary equipment is being eliminated, individual equipment items are being simplified, and wherever possible several equipment functions are being consolidated into one. Particular attention is being given to design for the reduction of maintenance requirements. As a result, newly-designed alkylation units offer to the refiner savings both in investment and operating costs, and as a result alkylation is comparatively more attractive today than it was a few years ago.

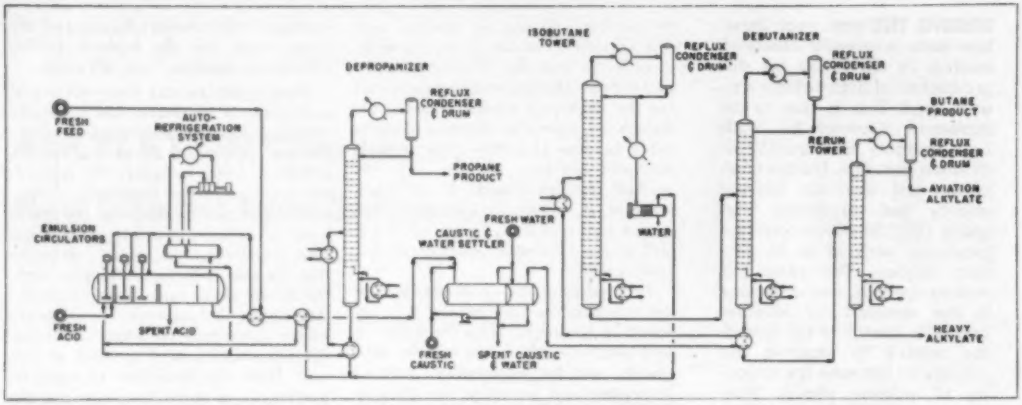


Figure 1. Simplified Flow Diagram of Modern Sulfuric Acid Alkylation Unit. Courtesy The M. W. Kellogg Company.

SULFURIC ACID Alkylation

ALKYLATION using sulfuric acid catalyst is licensed by The M. W. Kellogg Company, New York, under patent rights of Texaco Development Corporation, Standard Oil Development Company, Shell Development Company, and Anglo-Iranian Oil Company (Ltd.). Although a large number of sulfuric acid alkylation units were shut down following World War II, recently much interest has been re-focused on this process. Since the commencement of the Korean situation, refiners have been renovating and expanding existing alkylation units and adding rerun equipment in order to again produce aviation blending stocks. Within the last year orders have been placed with the Kellogg Company for three new sulfuric acid alkylation units. One of these was the East's first postwar alkylation unit, a 2180-barrel-per-day plant for California Refining Company's Barber Refinery in Perth Amboy, N. J. Although this unit was originally planned to help meet the "octane challenge" of the higher compression automobile engine, the design was modified half way through construction by the addition of facilities for splitting alkylate into light and heavy fractions because of increased military requirements for aviation gasoline. This plant, illustrated in the accompanying photograph, was placed on stream several months ago.

Figure 1 shows the flow sheet of a modern alkylation unit. Briefly the flow is as follows:[1] fresh feed from storage is heat-exchanged against the reactor effluent and then divided between the various reaction zones. Fresh acid and isobutane are introduced into the first reaction zone. After passing through the reaction zones the acid is settled out and withdrawn from the reactor. The hydrocarbon effluent, consisting of alkylate and isobutane recycle, after heat exchange, is caustic and water washed to neutralize any residual acidity. The isobutane recycle is then fractionated from the alkylate and normal butane in the isobutane tower, following which the alkylate is debutanized. Finally, in an aviation operation, the alkylate is rerun to meet the end point specification for aviation blending stock.

TABLE 2

Typical Yields and Inspections[6]

Sulfuric Acid Alkylation

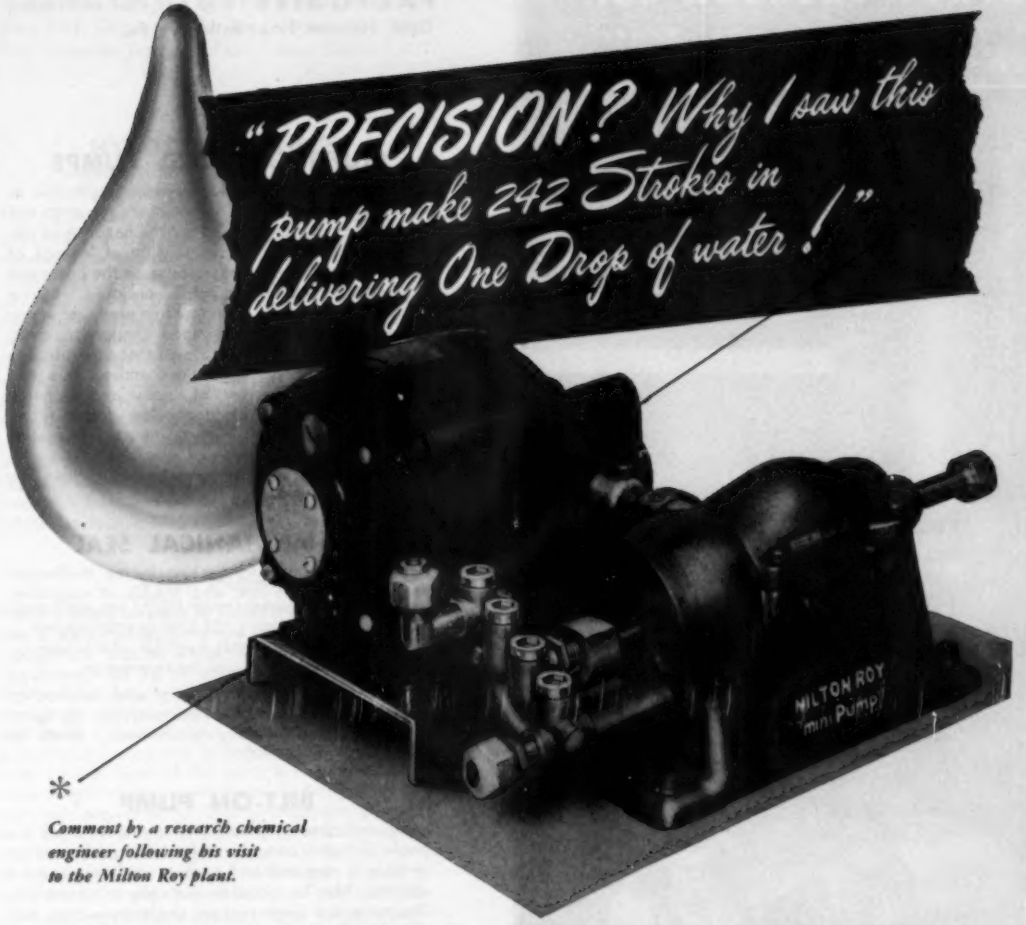
OLEFIN FEED	C_3	C_4	C_5
Alkylate Yield: Volume Percent on Olefins	173	172	155
Acid Consumptions (Approximate): Pounds per Gallon Total Alkylate (98 Percent Fresh—90 Percent Spent)	2.0	0.6	1.0
Octanes—Aviation Alkylate: ASTM Octane No. Clear	90	94	91
F-3 or 1-C Octane No. + 4.6 cc Tel	106	106	107
F-4 or 3-C Blending Index No. + 4.6 cc Tel	140-145	155-160	145-150

Refrigeration for maintaining the reaction temperature is supplied by vaporization of light hydrocarbons in the reactor. These vapors are withdrawn, compressed, condensed, and returned to the reactor. In recent designs centrifugal compressors have been used for the refrigeration system, working out well both from the standpoint of low first cost and a good utility balance. The centrifugal compressor may be driven by high pressure non-condensing steam and the exhaust steam used for reboiling the isobutane tower; or, it may be driven by electric power when high pressure steam is not available.

The compressor condensate is concentrated in propane, so that a portion of this stream is advantageously used for purging propane from the system. The purge is fractionated in a depropanizer, the bottoms product being returned to the reactor.

Sulfuric acid alkylation is used commercially for the alkylation of isobutane with propylene, butylenes, or amylenes. For the production of motor fuel, any of these olefins may be used individually, or in combination. However, propylene and butylenes are the only feeds that will interest the average refiner, since the C_5's are considered part of the motor gasoline cut. For the production of aviation components, however, alkylation of the C_4 olefins is definitely preferred because of the higher quality alkylates produced. As indicated in Table 2,[6] the rich mixture knock rating of butylene alkylates is definitely superior. Also given in this tabulation are typical alkylate yields, acid consumptions, and other knock ratings.

The reaction is usually carried out at 35-45° F. under a pressure slightly



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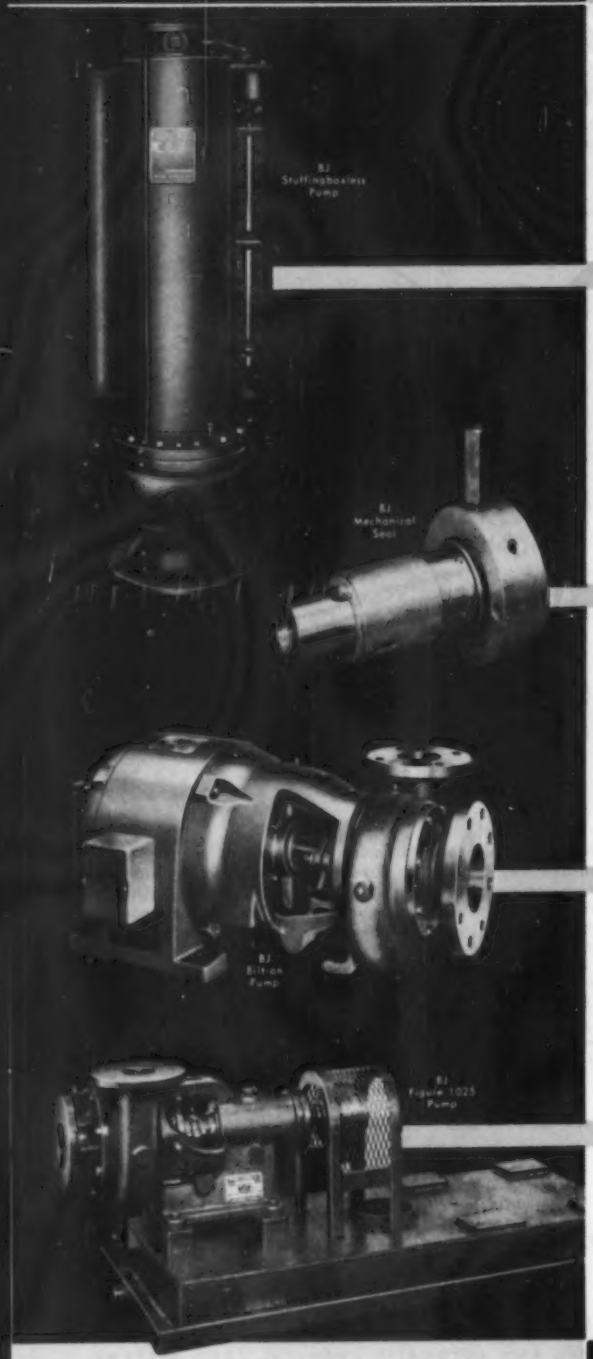

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FIGURE 1025 PUMP

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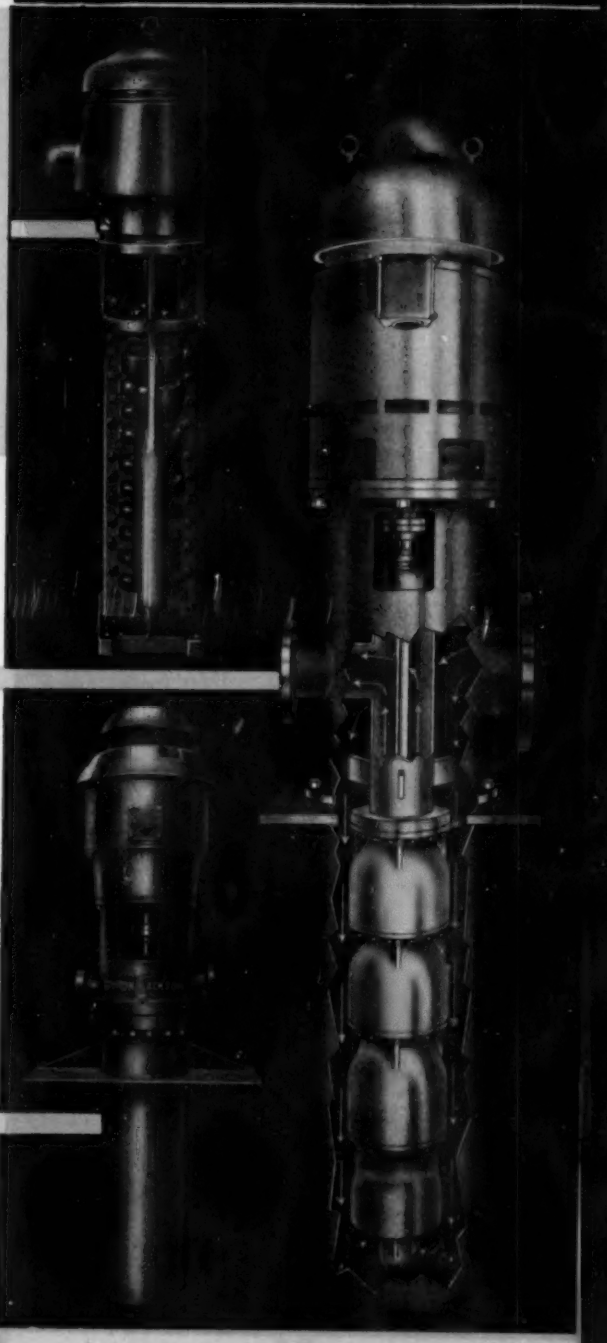
Head Range: 200-7000 feet.

The Hydropress unit is vertical double case multi-stage pump, sold only as a complete unit with the direct-connected driver. Designed for high speed, low capacity, high pressure operation, the Hydropress unit offers many advantages. These include uniform nonpulsating flow, variable capacities without by-pass or speed change, elimination of relief valves. Vertical construction allows use of a simple foundation and requires a minimum of floor space. Standard materials: Electric welded steel or forged outer case; semi-steel inner volute case; bronze fitted with stainless steel shaft. Special materials for unusual service requirements. Write for Bulletin No. 48-6400.



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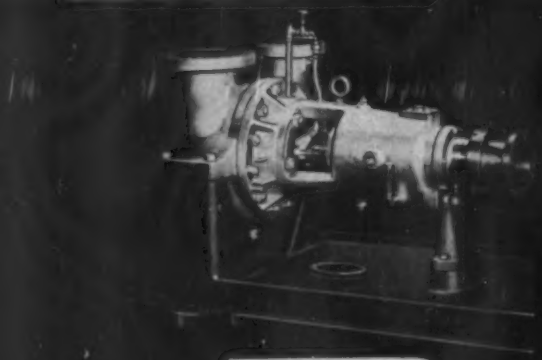
DOUBLE SUCTION HOT OIL PUMP

DOUBLE SUCTION HOT OIL PUMP
(SINGLE STAGE)

Capacity Range: 1000-7000 gpm.
Head Range: 100-700 feet.

Developed for capacities beyond the range of Single Suction Process Pumps. Design is based on proven principles of construction essential for superior service in handling high temperature liquids on continuous operation. Three pump sizes are available—6 x 8 x 10—6 x 10 x 14 and 12 x 16 x 20. Low entrance velocities and axial balance are obtained by use of a double suction impeller. Rotating element can be removed as a unit without disturbing the piping or driver. Pump can be constructed of a wide selection of materials to suit specific conditions.

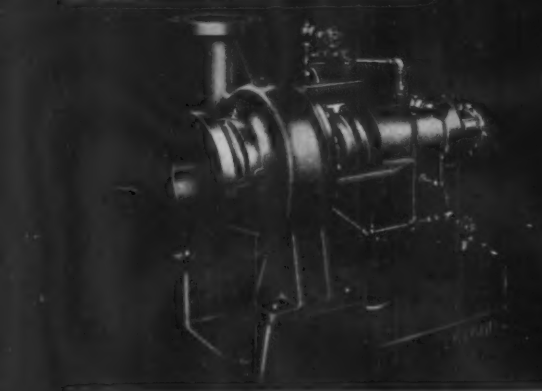


S. M. PROCESS PUMP

SM PROCESS PUMP

Capacity Range: 10-1400 gpm.
Head Range: 20-650 feet.

A horizontal, single stage, single suction, split case centrifugal pump for use where temperatures and pressures are high, suction liquid levels low, where hot and cold liquids near their boiling points must be handled, and where liquids impose severe conditions on stuffing boxes. An ideal pump for handling slurry. Alignment is maintained at any temperature. Bearing bracket, shaft and impeller assembly removable without disturbing piping, case, or driver. For temperatures to 850° F. Standard materials: Cases and impellers of cast iron, Meehanite, Ni-resist carbon or chrome alloy steel, or other alloy best suited to particular service. Write for Bulletin No. 49-2400.



ACID BUTANE PUMP

ACID BUTANE PUMP

Capacity Range: 2000-4500 gpm.
Head Range: 50-300 feet.

This special purpose pump is designed for handling acid butane and other corrosive liquids. It is a horizontal, single stage, single suction, split case centrifugal provided with a removable, split, water-jacketed, stuffing box for ease in packing. Impeller is arranged with wearing rings to obtain suction pressure on the stuffing box. Nozzles are adapted to conform to overhead piping. Bearing bracket, shaft and impeller assembly removable without disturbing piping, case or driver. Built in two sizes, 8 x 10 x 16" and 10 x 12 x 18". Materials to suit particular operating conditions.

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BJ STANDARD DEEPWELL

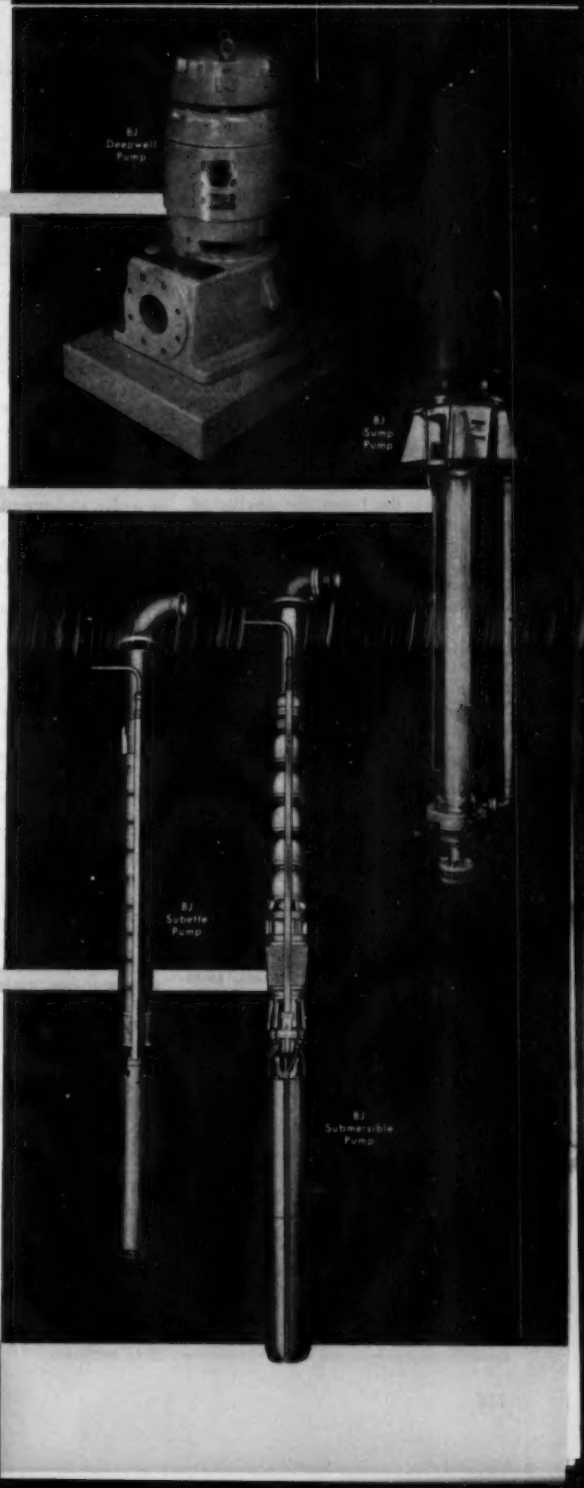
BJ Deepwell models answer practically every standard and special primary water supply need. Deepwell models are offered for well diameters from 6 to 24 inches and the new smaller "Bee-Jay" model is designed for 5 and 6 inch wells. Three distinct types of bowl assemblies and more than 100 individual impeller designs make possible the selection of a BJ Deepwell Pump to meet any conceivable requirement. As originators of the deepwell turbine pump, Byron Jackson Co. has continued to provide the best in deepwell pumping performance and dependability. Write for Bulletin No. 50-5000.

BJ SUMP PUMP

This Type TL Vertical Sump Pump is engineered in standard and special models to meet a wide range of sump applications. Five sizes are offered—$1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3 and 4 inches. Capacity range: 35 to 700 gpm. Heads from 15 to 85 feet. Solids up to the size of the strainer mesh opening can be pumped. Standard features include working parts of bronze and chrome; bronze throttle bushing; long lead-bronze sleeve bearings; vertical solid shaft 220/440 v motor; and 5' 10" motor barrel column. Special construction at extra cost provides additional column in 2', 4', and 6' lengths; explosion or splash-proof motor; open impeller; float switch and special fittings or materials. Write for Bulletin No. 50-7600.

BJ SUBMERSIBLE PUMPS

This model offers important installation and operating advantages not provided by any other type of pump. The pump and close-coupled sealed motor operate completely submerged in the well, with the motor driving the pump from below. Motor-pump unit is suspended on the column pipe. Power is supplied to the motor through an armored submarine cable. Installation is below the surface and out of sight, unaffected by atmospheric changes. No pump house is required and there's no possibility of flood-out. This pump is ideal for extra deep wells, crooked wells, locations where flood menaces exist, or for any installation where it is desirable to eliminate surface structures. With the Submersible, there's no problem of water contamination by dirt, oil or foreign matter. The regular Submersible is designed for wells 8" inside diameter or larger and offers capacities to 20,000 gpm and heads to 1500 ft. Write for Bulletin No. 50-5200. The new Subette model is designed for wells with an inside diameter of 6" or more and offers capacities from 30 to 130 gpm at heads from 65 to 765 ft. Write for Bulletin No. 51-5300.



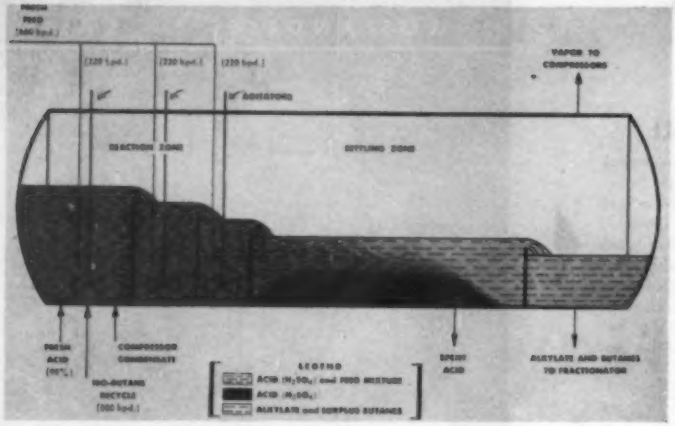


Figure 2. New Type Sulfuric Acid Alkylation Reactor. Courtesy, The M. W. Kellogg Company.

above atmospheric. The lower the temperature at which the reaction is carried out, the better the quality of the alkylate and the lower the acid consumption. On the other hand, below 35° F. the sulfuric acid-hydrocarbon emulsion tends to get so stiff as to make operations difficult. While 98 percent is the strength of the acid usually added to the process, the important factor is the average strength of the acid contained in the reactor.

An efficient sulfuric acid alkylation operation using butylenes consumes about 0.6 pounds of acid (working from 98 percent concentration down to 90 percent) per gallon of alkylate produced. When feeding propylene, the operation uses about 2.0 pounds, and on amylenes, about 1.0 pounds of acid per gallon. Recent commercial runs have indicated the possibility of stable operation with spent-acid strengths as low as 85 percent for both butylene and propylene-butylene feeds. Under carefully controlled conditions, such low spent-acid concentrations do not seriously reduce quality of alkylate and do lower over-all consumption of acid.[6]

A very important variable in the alkylation reaction is the isobutane to olefin ratio. It is necessary to maintain a considerable excess of isobutane in order to prevent the formation of olefin and acid-olefin polymers. The effectiveness of isobutane/olefin ratio is illustrated in Table 3, wherein data are shown on butylene alkylation at various ratios in an ordinary single contact reactor.[3] From a standpoint of yields and alkylate quality, it is evident that high isobutane ratios are desirable. However, from a practical standpoint it is costly to fractionate and recycle the isobutane necessary.

TABLE 3

Butylene Alkylation (H_2SO_4)

Reactor Temperature, Spent Acid Strength	35-40 °F. 90%		
Isobutane/Olefin Ratio in Feed	7:1	5:1	3:1
Yield Aviation Alkylate (380 E. P.) (Volume percent on Olefins)	163	160	156
ASTM Octane No., Clear	93.5	92.5	91.5

An ingenious method of high internal isobutane ratios, while necessitating only moderate external ratios is incorporated by Kellogg in a new reactor design.[6] This reactor, illustrated in Figue 2, has four principal design innovations which contribute to the quality and quantity of the alkylate produced.

Probably the most important is that the design provides for approximately a nine-to-one ratio of isobutane to olefin in the reaction zone, the three sections of which are shown at the left hand portion of the vessel. This is true despite the fact that the relation of isobutane to olefin as fed to the reactor as a whole is less than four-to-one.

A study of the sketch shows how this is brought about. Let us assume that the reactor shown here charges fresh feed at about 660 barrels per day. This feed, comprising a mixture of approximately 300 barrels of butylene and 360 barrels of isobutane, is divided into three equal 220 barrel-per-day portions, each of which is introduced into one of the three reaction sections.

To increase the amount of isobutane at the points of reaction, a recycle stream of isobutane from the unit's main fractionator is fed in at the bottom of the first section. This recycle must be at a rate of 800 barrels per day to provide an over-all four-to-one ratio between isobutane and olefin with fresh feed being charged at 660 barrels per day.

Adding up the total amount of isobutane in the first reaction section we find there are 920 barrels to 100 barrels of olefin. Naturally, since only about 110 barrels of the isobutane reacts with the total olefin present, about 810 barrels of excess isobutane are carried over into the second section where the cycle starts over again.

Thus, while the total amount of olefin charged each day in this typical case is 300 barrels and the total amount of fresh and recycle isobutane is 1160 barrels (a ratio of about four to one) the actual ratio at all reaction points is better than nine to one.

The second advantage of the design is found in the cascade flow of acid and feed from the first section onward. Fresh acid is charged to the first section and flows through the other two sections before entering the hydrocarbon-acid settling portion of the reactor. Since the olefin-isobutane reaction is a rapid one, it is completed in the reaction sections while the acid is still relatively high in concentration.

For example, if the operation is planned to feed 98 percent concentrated acid and to withdraw 88 percent acid, then the average acid concentration in the three sections will be 91.5 percent, a relatively high concentration which results in better quality alkylate.

A third point in the design is the use of agitators to provide highly efficient mixing in the reaction sections. With this agitating reaction, high quality alkylates have been produced with a horsepower requirement of 0.028 kwh. per gallon of alkylate as compared to 0.12 kwh. per gallon in reactors which utilize outside circulation and jet injection as a means of mixing.

And the final important advantage in the design is the use of auto-refrigeration to keep temperatures low. Since the reactor operates with a liquid level, heat of reaction is removed by vaporization. To permit continuous vaporization, a portion of the vapors is withdrawn from the top of the reactor. This gaseous fraction is compressed, condensed and returned to the reactor. The investment cost for this system is much lower than for the

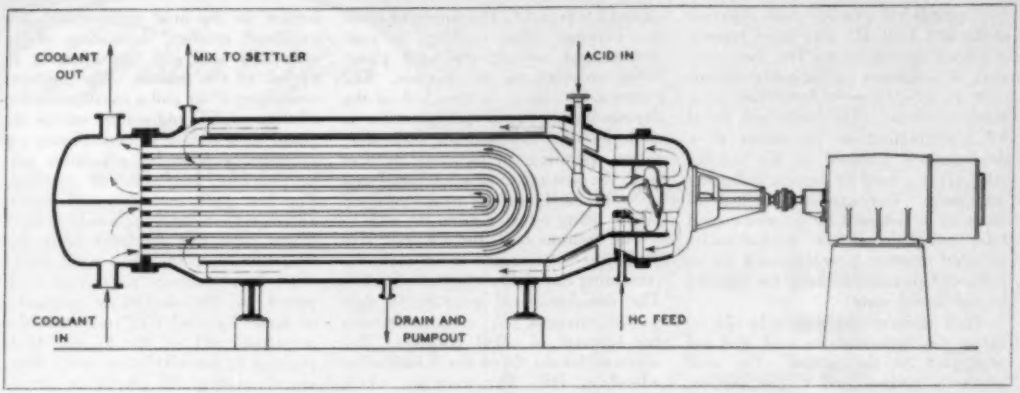


Figure 3. New Type Horizontal Contactor-Reactor. Courtesy, Stratford Engineering Corporation.

outside refrigeration-emulsion cooling systems.

Most of the sulfuric acid reactors built during the war, and still operating, are of the agitated heat exchanger type built by Stratford Engineering Corporation, Kansas City. There were 64 of these reactors built for sulfuric acid alkylation during World War II, most of which are now in operation. All of these were of the vertical type with a lance-type tube bundle utilizing extended finned surface.[3]

In the course of development work on alkylation, it was found that the rate of reaction is much faster than previously thought. It therefore becomes possible to feed considerably more material to most of the existing reactors and still have ample reaction residence time. The problem then becomes one of heat-removing capacity since such an increase in feed rate will also increase the load on the heat exchange bundle. However, a new tube bundle has been designed which provides over twice as much heat transfer duty in the same space. The new-type bundles, which can be installed in old reactors, utilize U-tube elements constructed of seamless tubing without welds or joints, except where rolled into the tube sheet. The elimination of all extended surface fins, welded joints and welded plugs in the tube bundle elements is a definite advantage since nearly all of the tube failures in the past have occurred at fin joints or welds.

The latest design of Contactor-reactor for sulfuric acid alkylation plants is as shown in Figure 3 with bare U-tube bundle and with acid inlet at the suction side of the impeller. Such a unit offers a number of economies as compared to the original vertical type unit. The horiizontal reactor requires no steel supporting structures. The drive is by means of a direct-connected explosion proof motor with all driving gears eliminated. In addition there are other advantages, such as shorter connecting pipes and the elimination of the recycle acid pump.[3]

HYDROFLUORIC ACID Alkylation

ALKYLATION using hydrofluoric acid catalyst is licensed by Universal Oil Products Company, Chicago, and also by Phillips Petroleum Company, Bartlesville, Okla. During World War II, there were 28 hydrofluoric alkylation plants built, 27 in the U. S., and one in Mexico. All of these plants were operating at the end of the war, but subsequently more than half of them were shut down due to the low demand for alkylate. Many of the war-time plants were scrapped, or revamped for other purposes.

At the present time 12 hydrofluoric alkylation units are operating, and 5 others are being planned for reactivation. The design capacity of these plants range from 1000 to 5000 barrels per day each, although some have produced as much as 7500 barrels per day.

Because of the renewed demand for high-quality alkylate, there is currently high interest in HF alkylation. Although HF was a few years ago a highly-feared chemical, and is still respected for its potential dangers, it has been found that with proper precautions HF can be handled quite safely. Indeed, one refinery reports a better safety record for its HF alkylation unit than the average for the rest of the plant.

Fundamentally, the HF alkylation process today is based on the same principles as during the last war. However, there has been considerable activity on the part of all companies concerned during the past year or two in improvement of mechanical design and certain process features. All unnecessary items of equipment have been eliminated, individual items of equipment have been simplified, and process functions have been combined wherever possible. Particular attention has been directed toward reducing the acid area to the bare minimum. In addition, the entire design has been reviewed and modified in order to reduce the maintenance requirements to the lowest possible level. As a result of these improvements, the new HF alkylation units are much more attractive from a standpoint of both initial investment and operating costs.

At the present time, seven UOP hydrofluoric alkylation units are in operation, and three additional war-time units are being revamped for startup. In addition, designs are being developed for new plants embodying many improvements resulting from past experience.

A simplified process flow diagram of the new UOP HF alkylation process is shown in Figure 4. The feed consists of isobutane and suitable olefins, such as propylene or butylenes, or a mixture thereof. The fresh feed, dried by fractionation or by means of a dessicant, is pumped to the reactor where it is joined by recycle isobutane and acid. The exothermic heat of reaction is removed by a water-cooled tube bundle, and the mechanically-agitated reactor is maintained under sufficient pressure to keep the mixture in the liquid state.

After intimate contacting in the reactor, the hydrocarbons and acid are separated in the settler. The acid phase is recirculated to the reactor, while the hydrocarbon phase, containing some dissolved acid, is pumped to the HF stripper.

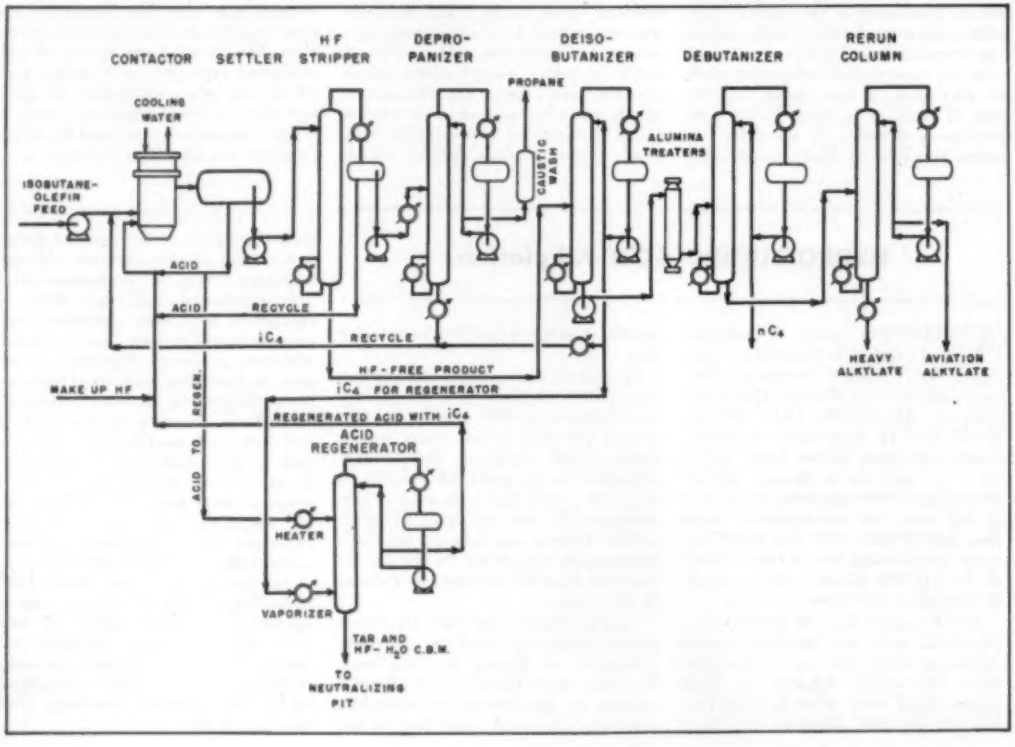
The purpose of the stripper is 1) to strip out all the HF from the bottoms product, 2) to remove the propane, and 3) to produce an isobutane-rich stream for recycle. The latter is a unique feature, for by this means it is possible to produce at low cost about 25 percent of the isobutane required for recycle. The overhead from the stripper, after settling, is condensed and settled, the acid phase being recycled to the reactor. The hydrocarbon layer is then fed to the depropanizer, where a separation is made between propane and isobutane. When operating on butanes-butylenes feed, the amount of propane produced is very small, and is caustic-washed before being released from the unit.

The bottoms from the stripper, free of HF, is fractionated to separate the remaining isobutane, which is recycled. The deisobutanized product is then passed through an alumina treater for removal of alkyl fluorides. The alumina breaks down the fluorides by adsorbing HF. The alumina, which normally is changed about every six months, is thrown away when spent. The treated product is finally debutanized, and rerun to separate aviation from heavy alkylate.

Some heavy polymers are formed in the alkylation reaction, but the catalyst has the advantage that it can be regenerated. This is accomplished by withdrawing the acid layer from the settler, and stripping it with isobutane in the acid regenerator. The overhead product, consisting of regenerated acid and isobutane, is recycled to the reactor. The bottoms, consisting of tar and a constant-boiling mixture of HF and water, can be disposed in a burner or neutralizing pit.

Olefin feeds to HF alkylation may be proylene, butylenes, or amylenes. The best feed materials are usually obtained from catalytic cracking operations, and the amylenes from this feed can be alkylated to good advantage. It is necessary to have up to 30 percent of the alkylate as isopentane to make 7-pound RVP, which allows essentially all of the C_5 cut to be charged to the alkylation unit. Amylene charged to HF alkylation units is converted approximately 45 percent of its volume to isopentane with essentially no increase in acid consumption over butylene alkylation. The C_5 components from catalytic cracking operations contain very little normal pentane. The feed requires no caustic or other treatment to remove sulfur. Actually HF is a better sulfur remover than caustic, and the sulfur leaves the processes with the bottoms from the

Figure 4. Hydrofluoric Acid Alkylation Process for C_3-C_4-C_5 Feed. (Courtesy, Universal Oil Products Company.)



Fluor Offers

THE MATHIESON SULFUR RECOVERY PROCESS

A simple process for the conversion of waste hydrogen sulfide to pure elemental sulfur

The availability of sulfur is rapidly becoming critical to the refining industry. First pinch was evident when sulfur and sulfuric acid were placed under allocation control by National Production Authority.

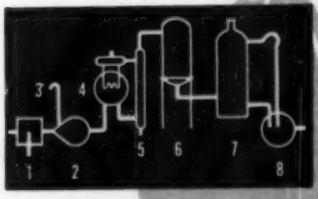
Primary cause of sulfur allocation is a gradual depletion of known deposits. Secondary cause is the great demand for sulfur in the manufacture of vital defense program materials. Mined sulfur is the normal source for such materials. The refiner, however, has in most cases his *own* potential source of sulfur.

Recovery from waste

The refiner's answer is the Mathieson Process for converting into sulfur the waste hydrogen sulfide recovered from sour petroleum gases. This simple process—available through The Fluor Corporation, Ltd.—accomplishes *two* important purposes:

1. *Guarantees independent supply* by affording each refiner an independent sulfur supply to meet his particular requirements—protection for the present, additional income for the future.

2. *Conserves for national defense* by contributing to the over-all National Defense Program in helping to conserve a critical commodity.



THE MATHIESON SULFUR RECOVERY PROCESS
Hydrogen sulfide, recovered from a sour gas stream, is partially burned with air—cooling follows with steam generated being utilized for power. Combustion gases are then passed through a catalyst tower to form sulfur and water vapor. Elemental sulfur product is condensed in a wash tower by direct contact with cooled liquid sulfur. The result is pure commercial sulfur—ready for sale or for conversion into sulfuric acid.

1—TREATING PLANT, 2—REACTOR FURNACE, 3—AIR INTAKE, 4—WASTE HEAT BOILER, 5—ECONOMIZER, 6—CATALYTIC CONVERTER, 7—SULFUR WASH TOWER, 8—RECIRCULATING SUMP

See Reverse Side

The Mathieson Sulfur Recovery Process

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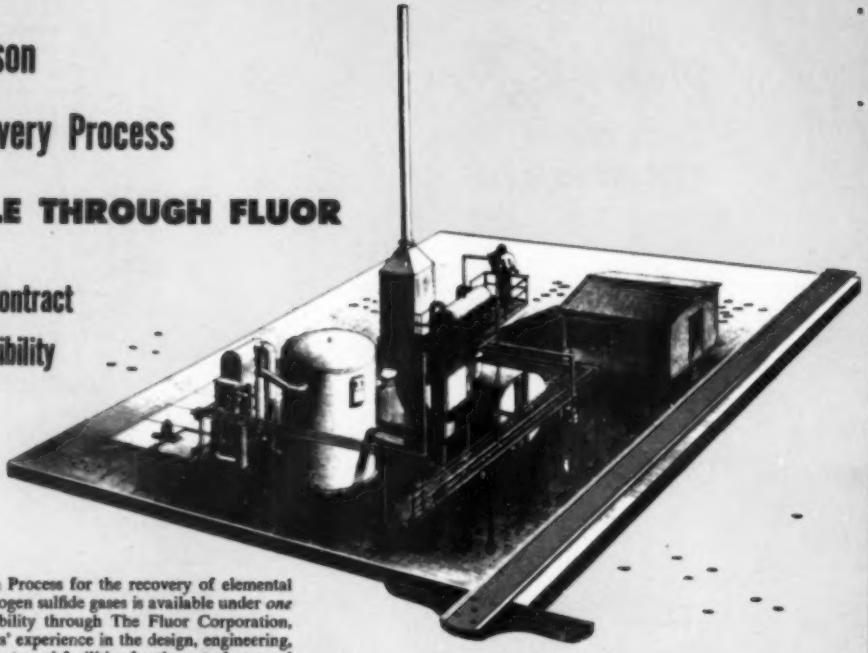
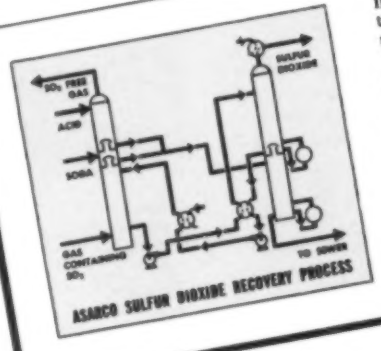


The proven Mathieson Process for the recovery of elemental sulfur from waste hydrogen sulfide gases is available under *one* contract, *one* responsibility through The Fluor Corporation, Ltd. With over 30 years' experience in the design, engineering, and construction of plants and facilities for the petroleum and chemical industries, Fluor possesses the background, the skilled personnel, and the know-how essential for the practical interpretation of the Mathieson Process into *your particular* sulfur recovery program.

Fluor is in a position to make economic studies covering every phase of proposed sulfur recovery installations—initial investment, operating costs, and returns to the investor.

A process for the recovery of Sulfur Dioxide is also available through FLUOR



ASARCO SULFUR DIOXIDE RECOVERY PROCESS

In line with Fluor's expanding activity in the fields of gas treating and sulfur recovery, arrangements have been made with the American Smelting and Refining Company (ASARCO) for Fluor to design, engineer and construct sulfur dioxide recovery plants using the ASARCO Process. Fluor's investigations have shown this process to be the most suitable of any available for the removal and recovery of pure sulfur dioxide from stack gases. In the application of the process, the gas is scrubbed with dimethylaniline which is then fed to a stripping column for sulfur dioxide recovery in a cyclic process. The resulting sulfur dioxide product may be dehydrated and liquefied for sale as liquid SO_2 or fed directly to an acid or sulfur plant.

All details including first studies are available through The Fluor Corporation, Ltd., and the American Smelting and Refining Company.

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TABLE 4
Properties of HF Alkylates

Properties of Rerun Alkylates	Butylene Alkylate	Propylene Butylene Alkylate	Propylene Butylene Amylene Alkylate	Isobutylene Polymer Alkylate
Gravity, °API	72.8	74.0	70.2	70.2
Reid Vapor Pressure, lbs.	....	5.5	2.0	2.8
D-86 Distillation:				
IBP °F.	....	94	130	....
5 percent	....	120	161	....
10 percent	136	136	181	190
30 percent	186	185	196	205
50 percent	212	215	204	216
70 percent	228	227	219	227
90 percent	230	237	239	237
EP °F.	309	314	327	320
Octane Ratings:*				
F-3 + 4.6 cc TEL/gallon	isoC8+1.15	isoC8+0.56	isoC8+0.79	isoC8+1.40
F-4 + 4.6 cc TEL/gallon	isoC8+ 3.2	isoC8+ 2.2	isoC8+ 2.4	isoC8+2.90
Performance Numbers:				
F-3 + 4.6 cc TEL/gallon	128	117	122	132
F-4 + 4.6 cc TEL/gallon	148	140	142	146

* Numbers are for iso-octane + cc TEL.

regeneration column.

The properties of typical rerun alkylates are given in Table 4.[4] It is apparent that both butylene alkylate and isobutylene polymer alkylate are superior in quality to the propylene-butylene alkylate and the propylene-butylene-amylene alkylates. It is also evident from these data that while all of these alkylates exceed the F-3 performance numbers required for the production of 115/145 grade aviation fuel, the alkylates produced from feeds containing propylene and amylene are somewhat short of the required F-4 performance number.

One of the advantages of HF alkylation is that refrigeration is not required to produce high-quality alkylate. Of the HF alkylation units operating during the war, only two employed refrigeration, these due to corrosive cooling water, and extremely high water temperatures. Present thinking is that refrigeration will not be used on any new units. Such units would be designed for a maximum reaction temperature of 90°F., which can easily be obtained if the temperature of cooling water does not exceed 85°F. Since the alkylates given in Table 4 were produced at a reaction temperature of 90°F., it is evident that these conclusions are sound. Even higher octane numbers can be produced at lower temperatures. With a reaction temperature of 90 degrees, the reactor pressures normally range from 100 to 120 psig.

It is necessary that the isobutane to olefin ratios in the reactor be high in order to produce high-quality alkylates. For aviation alkylate an external ratio of 6:1 is used, but for motor alkylate the ratio may be reduced to 3:1. The acid to hydrocarbon ratios used vary between 1:1 and 2:1.

The HF concentration in the acid phase should be about 87 percent. Normally the acid contains about 1.5 percent water, but the water content can reach as high as 5 percent without danger of corrosion of mild steel. The rate of acid regeneration is about 10 percent by volume of the alkylate production. The fresh HF makeup requirements amount to only 0.5 pound per barrel of alkylate produced.

The yields which can be obtained by alkylating propylene, butylene, amylenes, and codimer are given in Table 5,[4] as volume percent of the original catalytic cracking charge stock. The yields from the individual hydrocarbons are listed separately in this table, together with the isobutane required. It is assumed in these calculations that all of the isobutane produced and recovered from the catalytic cracking operations will be available. It is interesting to note that there is an excess production of isobutane when alkylating with each of the olefin streams separately in Case 1. When cracking the heavy gas oil in Case 2, however, insufficient isobutane is produced to combine with all of any one of the olefin streams produced, with the exception of the alkylation of codimer.

TABLE 5
UOP HF Alkylation Yields

Case	1	2
Charge Stocks to Catalytic Cracking	Light Mid-Continent Gas Oil	Heavy Mid-Continent Gas Oil
Charge Stocks to HF Alkylation, Vol. Percent of Charge to Cat. Cracking*:		
Propylene	5.8	4.6
Isobutylene	2.4	1.4
n-Butylene-1	5.0	1.7
n-Butylene-2		4.2
Isobutane	10.7	6.8
Amylenes	2.5	4.9
Codimer (from polymerization)	3.9	2.2
Yields from HF Alkylation Vol. percent of Charge to Cat. Cracking:		
Propylene Alkylate:		
Depent. 330° FEP Alkylate	9.3	7.4
Isobutane required†	1.4 (excess)	0.6
Butylene Alkylate:		
Depent. 330° FEP Alkylate	11.1	11.0
Isobutane required†	1.8 (excess)	2.0
Amylene Alkylate:		
Depent. 330° FEP Alkylate	3.7	7.2
Isobutane required†	7.1 (excess)	0.2
Codimer Alkylate:		
Depent. 330° FEP Alkylate	7.5	4.2
Isobutane required†	5.1 (excess)	3.0 (excess)

* Based on 75 percent C_3 recovery, 95 percent C_4 recovery and 100 percent C_5 recovery in gas concentration unit.

† Assuming above quantity of isobutane available in each case.

The material of construction used in the major portion of HF alkylation units is ordinary carbon steel. HF reacts with iron to form iron fluoride, which adheres as a hard protective coating on all steel surfaces. For this reason the reactor, settler, and HF stripper are of low carbon steel. However, the iron fluoride scale is detrimental to all moving parts with metal-to-metal contact. For this reason it is necessary in HF service to use monel-trimmed pumps and valves. Because of the highly-corrosive conditions, it is necessary to employ solid monel on the acid regenerator and preheater tubes.

There are many other improvements which have greatly reduced maintenance. Most of the valves in the HF section have been eliminated. Similarly, all except one pump has been eliminated in this section. There are no flowmeters in acid service. In order to determine the amount of acid sent to regeneration, the heat balance around the preheater is utilized as indicated by the temperature on the preheater effluent.

Because of these and other improvements, maintenance on equipment in acid service has been practically eliminated. One alkylation unit schedules its shutdown and inspection only once in two years. This of course contributes to considerable savings in operating costs.

It is also expected that initial investment costs on new HF alkylation units will be less than as previously designed. These savings are attributed to the simplification in equipment and design. Thus, as a result of savings in both investment and operating costs, it is expected that there will be a considerable new interest in HF alkylation for the production of high-octane fuel components.

REFERENCES

[1] Jewell, Jr., J. W., and King, C. C., "Sulphuric Acid Alkylation for Motor and Aviation Gasoline," paper presented at the Western Petroleum Refiners Association meeting at San Antonio, Texas, April 4, 1951.

[2] Oden, E. Clarence, Burch, Jr., W. J., and Jones, G. R., Petroleum Refiner, **29**, April, 1950, p. 103.

[3] Putney, D. H., Petroleum Refiner, **30**, June, 1951, p. 89.

[4] Read, Davis, Petroleum Refiner, **30**, March, 1951, p. 130.

[5] Van Winkle, M., Petroleum Refiner, **30**, May, 1951, p. 89.

[6] "Improvements in Sulfuric Acid Alkylation Process," Petroleum Refiner, **30**, Feb., 1951, p. 93.

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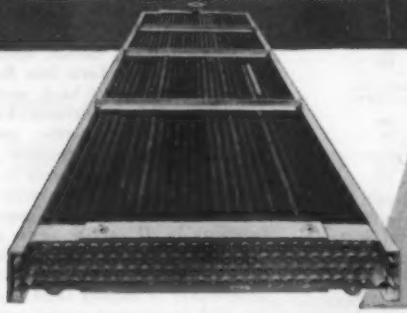

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Socony-Vacuum Airlift TCC Unit

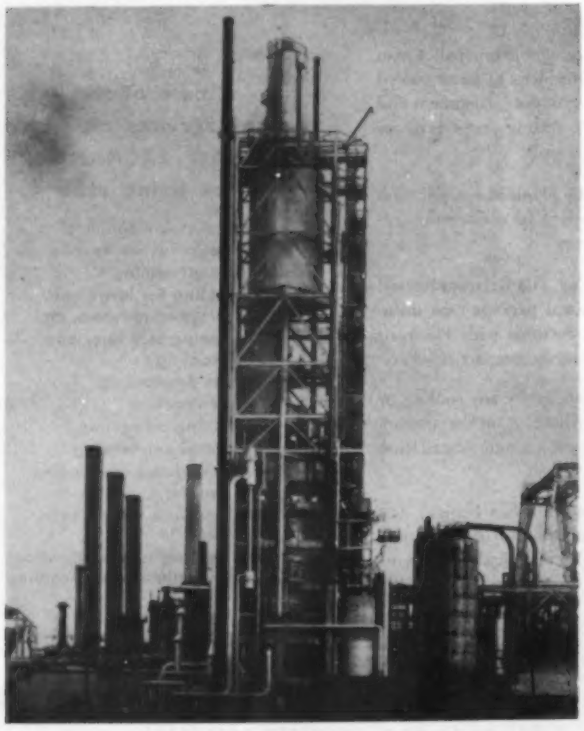
CATALYTIC CRACKING More Attractive than Ever With New Design Improvements

Socony-Vacuum Oil Company, Inc.

THE development of catalytic cracking continues with design improvements in all the major processes. With the increased demand for more and more high-quality gasoline, catalytic cracking has become a must in refining operations. Since VJ-day, approximately 800,000 barrels per day of new catalytic cracking capacity of all types has been or is being installed. This is accompanied by design improvements which have reduced investment requirements, simplified operation, decreased downtime, and reduced operating costs. Reviewed here are recent developments in a number of the catalytic cracking processes.

SOCONY-VACUUM Oil Company, Inc., pioneered modern catalytic cracking through work Vacuum Oil Company started more than 20 years ago. After the merger in 1931 of Standard Oil Company of New York with Vacuum Oil Company to form Socony-Vacuum Oil Company, Inc., this catalytic cracking development work was continued, culminating in 1936 with the start-up of the world's first commercial catalytic cracking unit (a fixed-bed) at its Paulsboro, N. J., refinery.

Recognizing the drawbacks to cyclic fixed-bed cracking, Socony-Vacuum engineers soon commenced development of a continuous catalytic cracking process which was simpler and more flexible. Bench-scale and semi-commercial units of the continuous type were erected and operated in Socony-Vacuum's laboratories. This was part of a continually expanding effort in the field of catalytic cracking and catalytic cracking catalysts at these laboratories which resulted in the development of the Thermofor catalytic cracking (TCC) process and spherical cracking catalyst. During the war years and shortly thereafter, more than 35 TCC units were installed throughout the industry.



Airlift TCC Unit at a Socony-Vacuum Refinery.

During the postwar years Socony-Vacuum has been developing its new Airlift TCC unit. The design of this new unit embodies not only an airlift to replace the bucket elevators which were present in the original TCC units, but also involves a complete new design for the kiln and a new general arrangement. The first commercial unit of this design to go on stream was the one at Magnolia Petroleum Company's Beaumont refinery which has been in operation since October, 1950. At the middle of 1951, some 19 TCC units of the airlift design have been or are being built in the United States by Socony-Vacuum and licensees of Socony-Vacuum which units will have a combined capacity of 250,000 barrels

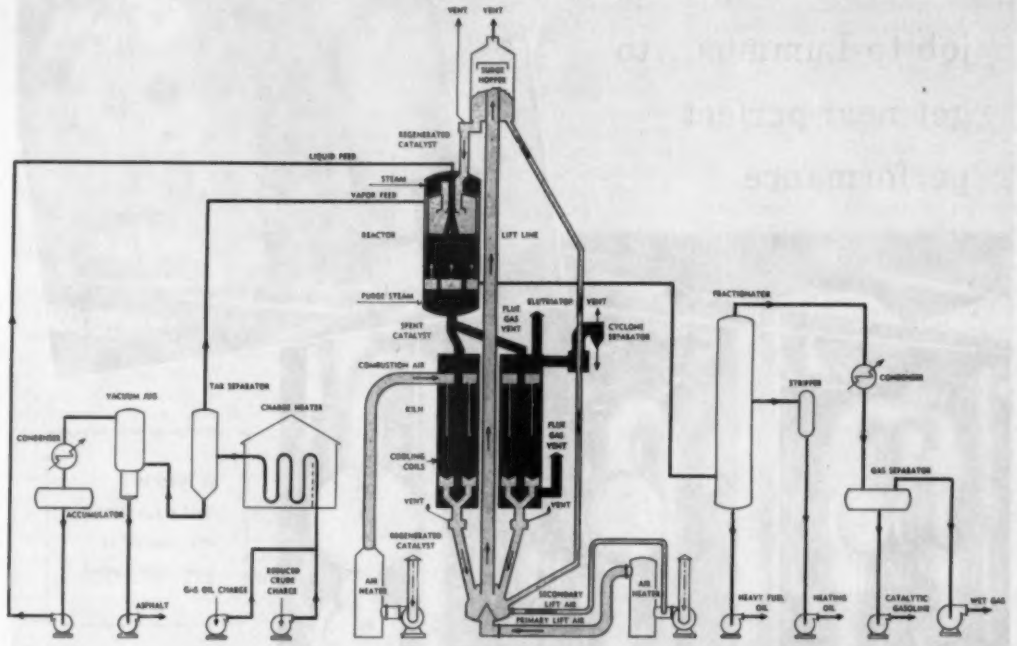


Figure 1. Airlift TCC Catalytic Cracking Process. (Courtesy, Socony-Vacuum Oil Company, Inc.)

daily. In addition to the units being constructed in this country, a total of 11 units have been licensed for construction in other parts of the world which will have a combined capacity of 110,000 barrels daily. The first of these foreign units to go on stream will be that at the Frontignan, France, refinery of Socony-Vacuum Francaise, which was expected late this summer. This gives a total capacity for Socony Airlift TCC units of more than 350,000 barrels per day.

The Socony Airlift TCC Unit

Results of Socony-Vacuum's extensive program of research, development and engineering directed toward improving and simplifying the TCC process, together with Socony-Vacuum's basic knowledge of catalytic cracking in a moving bed of catalyst, have established a sound foundation for the design of the new Airlift TCC unit. This unit combines the advantages of even easier and simpler operation than the bucket elevator type TCC designs, which were noted for this feature, with greater flexibility to process a wider range of stocks including the heaviest now being charged to any type catalytic cracking process. The unit can be operated at varying severities and for various product distributions, in accordance with the requirements of refinery production schedules. As a result of the simplifications, investment cost and operating costs have been reduced but at the same time the Socony Airlift TCC unit retains all of the basic advantages of high-liquid recovery, high-catalyst activity, high-cracking efficiency and high gasoline-to-coke ratio, associated with previous TCC operations.

The catalytic section of the Socony Airlift TCC unit is described herewith. For convenience this description covers: 1) the flow of catalyst in the unit; 2) the flow of oil vapor through the reactor; and 3) the operation of the kiln where the carbonaceous deposit is burned off the catalyst by combustion with air. A flow diagram is shown in Figure 1.

Catalyst Flow

The flow of catalyst in the unit is best described by starting with the lift pot. This vessel receives regenerated catalyst by gravity flow from the kiln. Low-pressure air (at a pressure of about 2.0 psig) is introduced into the lift pot and the catalyst is picked up by the air and is lifted to the top of the unit, where it is disengaged from the conveying air and collected in the separator-surge hopper. At this point, the lift air is vented to the atmosphere.

The operation of the lift is simple. Catalyst circulation can be easily controlled at any rate below the maximum. Lifts may be designed to convey catalyst at any desired rate. Typical commercial units have maximum conveying rates from 50 to 600 tons per hour. Little catalyst attrition occurs in a properly designed lift system.

Catalyst collects in the separator-surge hopper and from there flows by gravity as a compact mass through the system back to the lift pot at the foot of the structure. More specifically, leaving the surge hopper the catalyst flows down the seal leg to the reactor. Pressure in the top of the reactor ranges from 7 to 15 psig, depending on the pressure drop through the reactor and fractionating system to the gas separator. The use of sealing steam or flue gas flowing countercurrent to the descending catalyst in the seal leg makes it possible to move the catalyst from a zone of atmospheric pressure (the separator-surge hopper) to a zone of higher pressure (the reactor). Catalyst entering the reactor is distributed in such a manner as to avoid segregation of fine and large particles, and

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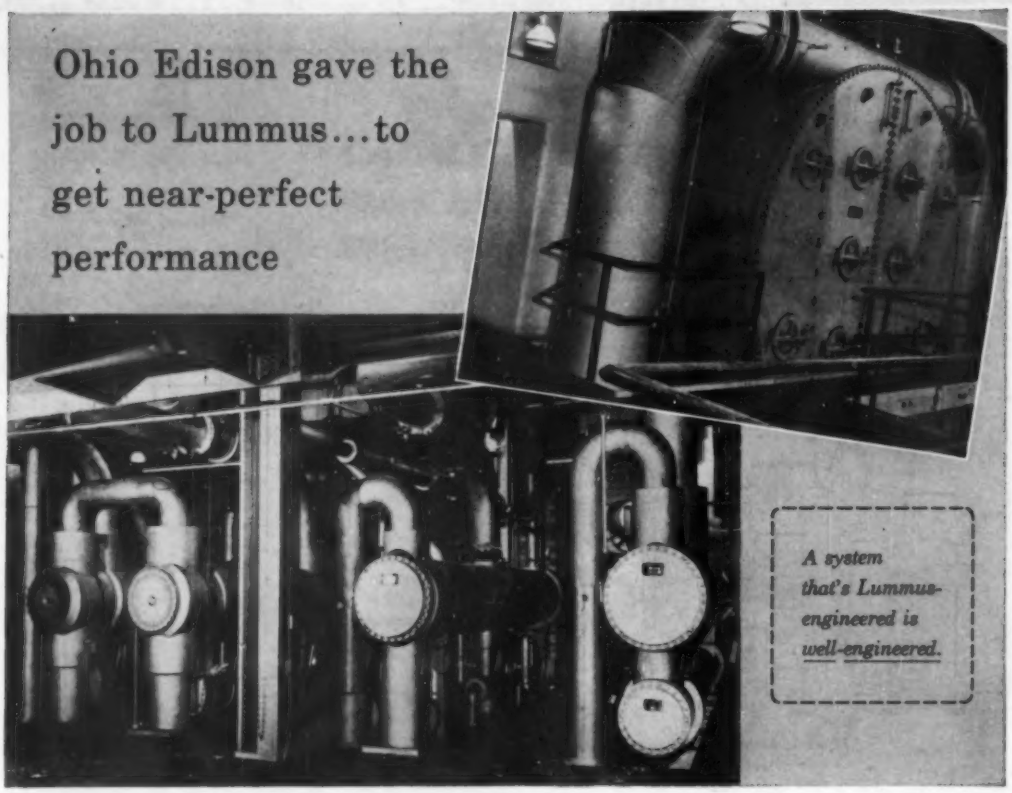

A system that's Lummus-engineered is well-engineered.

The surface condenser, feed water heaters, and exchanger shown above are part of a Lummus system installed early in 1944 in the Gorge Power Station of Ohio Edison Company, Akron. Operating records for the intervening years bespeak sound design and fabrication.

The condenser (effective surface of 32,600 sq. ft. to condense 350,000 pounds of steam per hour) has operated over this period without overhauling of shut-down magnitude. Equipped with a deaerating-type hotwell of Lummus design, deaeration has been constant over loads varying from 25% to normal capability of 45,000 kw. Condensate has been tested every shift for oxygen content. Throughout the seven-year run, readings have fallen consistently within what our customers' engineers consider "zero"—a maximum of .005 cc. per liter!

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so that a catalyst bed of uniform depth is maintained in the reactor.

Reactor

Catalyst in the reaction bed flows uniformly down through the reactor past the oil vapor collecting grids, and thence through catalyst collecting devices that insure uniform flow of the catalyst over the cross-section of the reactor. Passing from the reactor, the catalyst flows by pipes to the regenerator. Here it is redistributed and flows first into a zone where it is contacted countercurrently with air, then to a zone where it is contacted concurrently with air and in which there are cooling coils, and then past flue gas disengaging grids and finally through catalyst collection devices and thence into the lift pot. Meter boxes are provided to positively measure the flow of the catalyst from each section of the kiln. It is interesting to note that these meter boxes are vented to the atmosphere and that the cover may actually be lifted to observe the catalyst flowing through the weir or to permit removing of a sample at this point. The lift system can be adjusted to maintain the desired flows in the various sections of the kiln. The temperature of the catalyst entering the reactor is controlled by adjusting the cooling coils in the lower section of the regenerator.

A small stream of catalyst is withdrawn from the separator-surge hopper (usually about 5 percent of the circulation) and passed through the elutriator or gas classifier where the freshly falling stream of catalyst is dropped through an ascending stream of flue gas of controlled velocity. This secondary catalyst circuit is used to remove fine particles from the system.

Oil in the form of vapor is introduced through the side of the reactor at the top of the bed and liquid oil as a separate stream may enter through a nozzle suspended from the head of the reactor. The liquid oil charge is fed through a nozzle within a falling curtain of catalyst and a uniform mixing of the catalyst and oil is obtained at the top of the bed. All of the oil feedstock then passes uniformly down through the catalyst bed and the cracked vapors are disengaged from the catalyst in collectors in the lower section of the reactor.

Purge steam is introduced into the catalyst stream below the point of oil vapor disengagement. Countercurrent flow of the steam insures substantially complete removal of entrained vapors and adsorbed oil from the catalyst before it passes into the regenerator. Failure to properly strip off the oil at this point results in loss of valuable hydrocarbons and increases the burning load on the kiln unnecessarily at the expense of liquid product yields.

Regenerator

The regenerator or kiln removes carbonaceous deposits from the catalyst under carefully controlled conditions of combustion. A properly designed kiln must provide for uniform removal of the combustible deposits on the catalyst to a low level, and for controlled temperatures so that catalyst activity is not impaired. In the Socony Airlift TCC unit, low-pressure air (at a pressure of about 2 psig) is introduced into the middle of the regenerator. Part of the air passes up through the descending catalyst and is removed from the top of the kiln as flue gas. The quantity of air flowing upward is controlled by a back-pressure valve on the upper stack. The other portion of the air flows downward with the catalyst, over rows of cooling tubes, and then is collected in disengaging channels and led to the lower stack for disposal. It should be noted that the incoming catalyst containing the maximum carbonaceous deposits is met by a stream of flue gas low in oxygen content and also that the catalyst is at a comparatively low temperature as it emerges from the regenerator. The catalyst reaches a peak temperature just before the introduction of the cool combustion air. This cool incoming air reduces the catalyst temperature, but combustion in the lower section of the kiln gradually raises it to another peak just before it passes over the cooling coils. The cooling coils serve to remove heat of combustion and to lower the temperature of the catalyst to the level desired for introduction to the reactor. At the same time the temperaure of the flue gas is also reduced, thus suppressing any tendency toward afterburning, and increasing the thermal efficiency. Treated water is circulated through the cooling coils and steam is generated from the heat removed at this point.

In addition to the major items of equipment just described, the catalytic section includes low-pressure (single stage, centrifugal) blowers to supply air for the catalyst lift and for regeneration; a steam drum to separate the water from the steam generated in the kiln cooling coils; air heaters in which lift and combustion air may be heated by direct combustion of fuel to provide additional operating flexibility and to provide heat for initially warming the unit; storage bins for fresh catalyst fines and for holding the entire contents of the system during a shutdown and a small elevator for handling the fresh make-up catalyst.

It is particularly noteworthy that the TCC process requires only low-pressure air, both for the kiln and for the lift. Hence the blower requirement involves only a simple, single-stage machine or relatively low horse power.

TABLE 1

Typical Results of Socony-Vacuum Airlift TCC Unit Operation on Mid-Continent Charging Stock

	Weight, Percent	Volume, Percent
Reactor Charge	100.0	100.0
Yields:		
Debutanized Gasoline (385° F./90%)	42.8	49.1
No. 2 Fuel Oil	28.9	28.9
Heavy Cycle Stock	3.4	3.0
Isobutane	5.4	8.4
Butylenes	4.0	3.8
Normal Butane	1.5	2.3
Propane	2.2	....
Propylene	2.9	....
Ethane and Lighter	2.8	....
Inerts (N_2, CO_2, CO, etc.)	Nil	....
Coke	6.1	....
	100.0	....
Total Propane—Free Liquid	....	97.5

Package-Type Airlift TCC Unit

In addition to the Airlift TCC design worked out for larger size units, Socony has engineered an Airlift TCC design for units having total charge capacities below about 6000 barrels daily. This "package" design employs the same moving bed principles and the same airlift for catalyst as used in the design for larger units.

An objective of the "package" TCC design was to provide a TCC unit for the smaller capacity ranges which would have an investment cost per barrel of capacity in line with the investment cost per barrel of capacity for larger TCC units. To attain this objective, all vessels of the "package" units have been so designed that they can be shop fabricated and shipped to the plant site by railroad. In fact, all items of equipment can be prefabricated so that the job at the plant site can be one primarily of field erection rather than field construction. The structure for the "package" TCC unit has been designed so that it can be erected first and then be used to lift the vessels into place. This feature eliminates the need for bringing heavy rigging equipment into the field.

Operations

At the time of this writing (July, 1951) eight of the Airlift TCC units are in operation; four of these charging a liquid feed stream. Of the total

number of units constructed or licensed to be constructed, 80 percent have the liquid feed feature incorporated in their design. Even those units without liquid feed can be easily modified to handle it, should it be desired at a later date.

In July, 1951, Socony-Vacuum's Casper, Wyo., refinery completed its second year of operation using liquid feed. The liquid charged to the reactor during this two-year period has been that fraction boiling immediately before 130° F. softening point asphalt. In a similar operation at Socony's Buffalo, N. Y., refinery, the liquid charge stock was that immediately before 95° F. softening point asphalt.

Presented in Table 1 are typical commercial yields on a Mid-Continent type charging stock during a liquid feed operation at the 68 percent conversion level.

HOUDRIFLOW Catalytic Cracking

Houdry Process Corporation

THE HOUDRIFLOW process was first announced to the petroleum industry by Houdry Process Corporation in late 1948. It featured the use of a flue gas lift for transportation of the catalyst. Thus, for the first time, circulation of the catalyst by pneumatic means was made available for the TCC type of moving-bed catalytic cracking units. Since that date, ten commercial Houdriflow units have been built and put into operation.

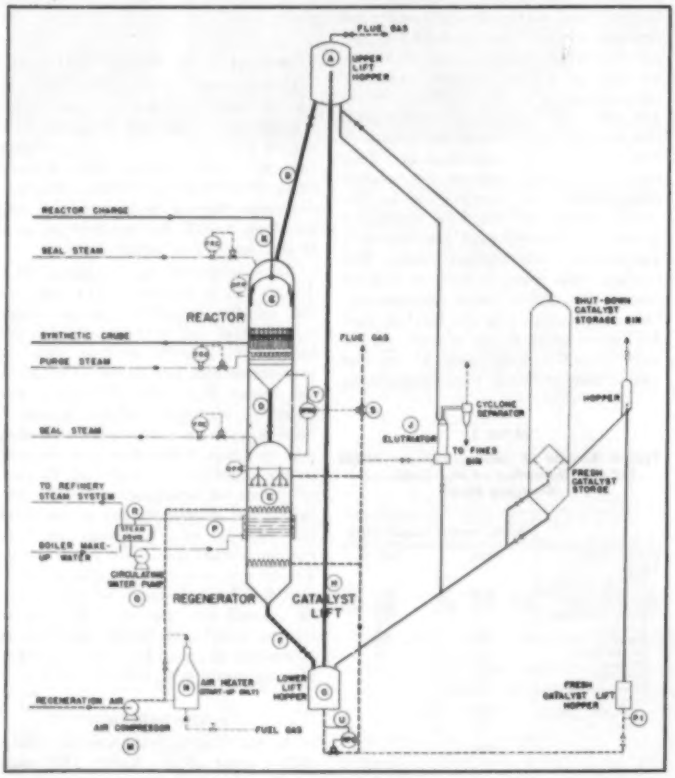

Figure 2. Houdriflow Catalytic Cracking Process—Basic Design. (Courtesy, Houdry Process Corporation)

Since the first commercial Houdriflow unit was built, several significant changes in the design have been evolved. Actually, the existing units may be grouped into two classifications, the principal difference in the two designs being the manner in which the pressure balance of the reactor-kiln section is maintained.

The early units, which include the Sun, Tide Water, and Petco plants, are typified by the flow diagram presented in Figure 2. In this design the regenerating kiln is maintained at essentially the same pressure as the reactor; a multistage blower compresses the regeneration air to kiln pressure and the effluent flue gases from the kiln are at a sufficiently high pressure to be used directly as motive medium in the catalyst lift.

All of the later units are similar to the design illustrated in Figure 3. The kilns operate at 3-psig pressure or less so that a single stage blower may be used to compress regeneration air and that portion of the kiln flue gas required for lift operation is recompressed by means of thermocompressors. The latter design has the advantage that the reactor may be bypassed at any time without disturbing the pressure balance of the kiln and lift systems.

Sun Oil Company, Toledo

The Houdriflow catalytic cracking plant at the Toledo, Ohio, refinery of Sun Oil Company was the first Houdriflow installation to go on stream, in the spring of 1950. An unusual feature of this installation is that four complete and separate Houdriflow units are erected within a single structure. This arrangement provides a maximum of flexibility in the use of different catalysts and charging stocks. Also, shutdowns for inspections and repairs can be made on individual units without total loss of production so that both manpower and tankage requirements are minimized.

Each unit at Toledo is designed to process atmospheric and vacuum gas oils with or without internal recycling at a total charge rate of 7000 barrels per stream day. Actual charge rates have exceeded the design value. Both natural clay and synthetic silica-alumina bead catalysts have been used.

In a typical operation, the charge rate of 7300 barrels per stream day to one unit consisted of 31 percent light virgin, 44.5 percent vacuum and 24.5 percent first pass catalytic cycle gas oils, (Houdry fixed-bed) for 6360 barrels daily of fresh feed plus 940 bar-

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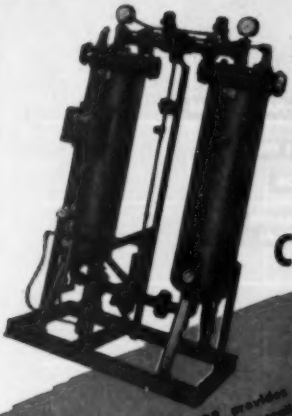

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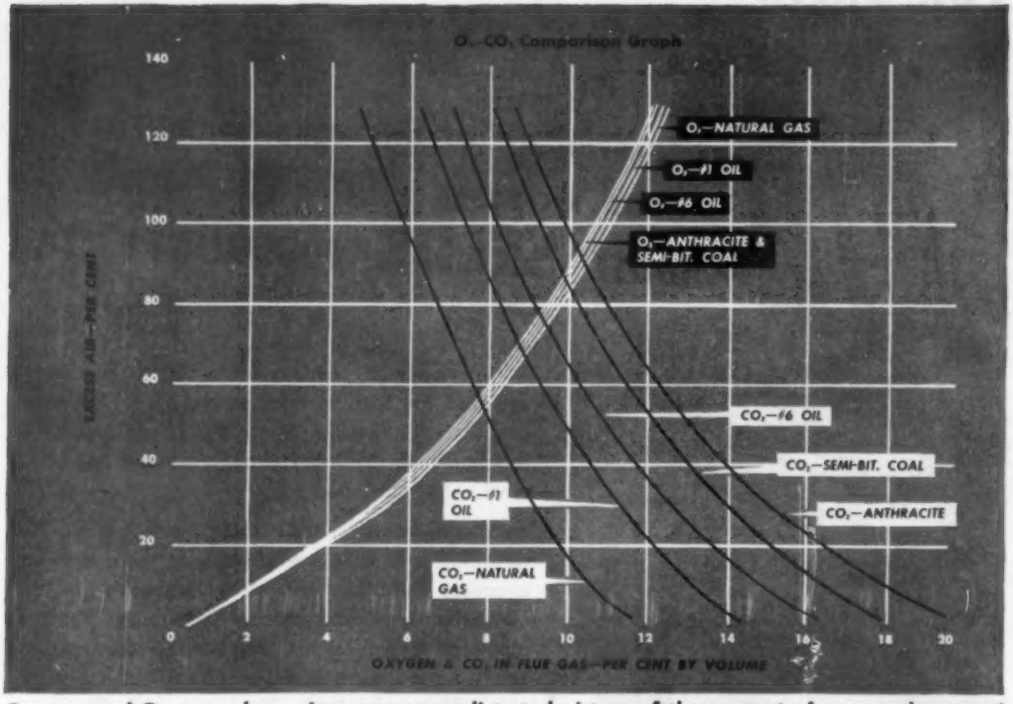

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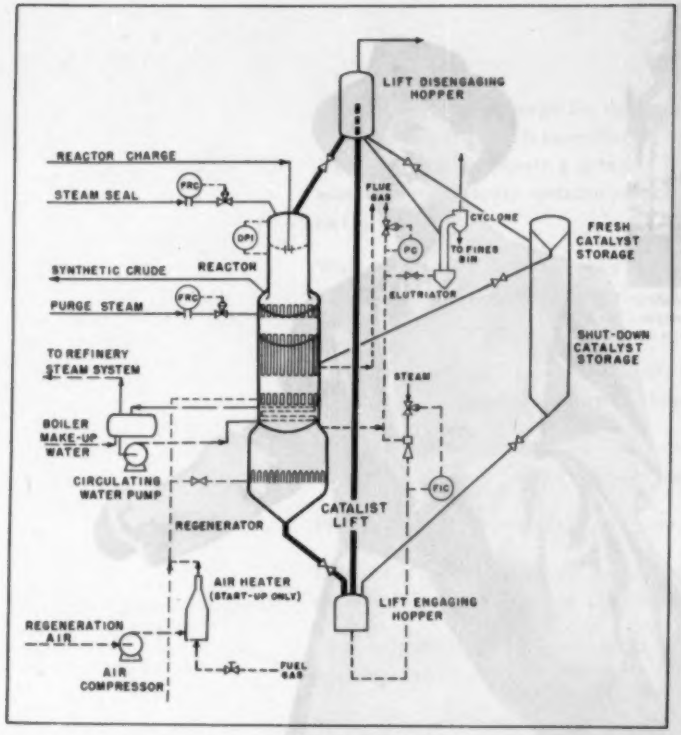

Figure 3. Houdriflow Catalytic Cracking Process, Modified Design. (Courtesy, Houdry Process Corporation.)

rels daily of internal recycle gasoil. Cracking over natural clay catalyst at 870° F. average reactor temperature gave a yield of 47.8 volume percent of 10 pound RVP, 385° F. @ 90 percent gasoline having an 87.5 clear research octane number. C_4 plus liquid recovery was 100.4 volume percent of fresh feed.

The Toledo units were originally equipped with single 19-inch i.d. lift pipes. At a 200-ton-per-hour catalyst circulation rate per unit, catalyst attrition rates were about 3.5 tons per day with beads and 5 tons per day on clay. The single lift pipes have subsequently been replaced with multiple lift systems consisting of seven 8-inch lift pipes in parallel per unit. With the multiple pipe systems, catalyst attrition has been reduced to about 1.6 tons per day with beads and 1.9 tons per day with clay for 200 tons per hour circulation.

A feature of the Toledo installation is the complete "graphic panel" control board. All important flow and pressure measurements, valve controls and alarm signals for the four units are grouped on four 4- x 8-foot flow-diagram-type control panels, thereby providing exceptionally centralized control of the cracking units.

Tide Water Associated Oil Company, Drumright

The Houdriflow unit at Drumright, Okla., was one of the original Houdriflow designs. It has been in operation since the summer of 1950.

Originally, the gas lift of the Tide Water unit consisted of a straight pipe, 19 inches in diameter throughout, equipped with appropriate engaging and disengaging vessels. After several months of operation, the system was modified to include a tapered decelerating section at the top of the lift pipe. The lift system now operates with about 4 psig pressure at the base and requires about 4000 standard cubic feet per minute of lift gas when circulating 225 tons per hour of synthetic chrome bead catalyst. The catalyst make-up rate averages about three tons per day.

TABLE 2
Tide Water Houdriflow Yields

Dry Gas	7.2 Wt. percent
Butanes	16.5 Vol. percent
Gasoline, 425° F. E.P., 8-lb. RVP	51.5 Vol. percent
No. 2 Fuel Oil	23.0 Vol. percent
Heavy Gasoil	9.0 Vol. percent
Coke	5.1 Wt. percent

Fresh charge to the unit is vacuum gas oil produced from Scurry County, Texas and Oklahoma crude oils. The design fresh charge rate is 4500 BPSD with 2250 BPSD of internal recycle bringing the total charge rate to 6750 BPSD. Typical yields for the operation are presented in Table 2.

Salt Lake Refining Company, Salt Lake City

The Salt Lake Houdriflow unit has been in continuous operation since early 1951. The unit processes per stream day 10,000 barrels of fresh feed with an additional 3000 barrels of internal recycle. The fresh oil charge, prepared from Rangely crude, has a boiling range of 600° F. to 1000° F. and contains approximately 1.0 weight percent sulfur. This material, which is fed to the reactor substantially as liquid (about 15 percent vaporized), is the overhead product of a vacuum distillation and vacuum flasher operation on Rangely reduced crude. These operations reduce crude residuum to a yield of about 10 percent. Bead catalyst is circulated through the unit at the rate of 335 tons per hour. The catalyst make-up rate is currently averaging 2.6 tons per day. Typical yields are given in Table 3.

TABLE 3
Salt Lake Houdriflow Yields

Dry Gas	6.1 Wt. percent
Butanes	14.9 Vol. percent
Debutanized Gasoline	48.4 Vol. percent
Light Gasoil	20.3 Vol. percent
Heavy Gasoil	22.5 Vol. percent
Coke	2.8 Wt. percent

Petco Corporation, Blue Island, Ill.

The Great Lakes Refining Division of the Petco Corporation operates a Houdriflow unit at Blue Island, Ill. The raw feed to this plant consists of approximately 5600 BPSD of 47 percent crude bottoms produced from Texas Empire Pipe Line crude in an atmospheric crude unit. The reduced crude and approximately 1200 barrels of recycle stock flow through conventional heat exchange equipment into a center-fired, horizontal, circular heater and are discharged at about 840° F. into a low-pressure flash tower. The vapor from the flash separation passes directly to the Houdriflow reactor. Additional reactor charge is derived from a unique integral visbreaking circuit in the feed prepara-

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1942... Cyanamid starts production of synthetic fluid cracking catalysts at Ft. Worth to help refiners meet the demand for high octane fuel.

1946... Cyanamid expands Ft. Worth plant.

1946... Cyanamid becomes the *first* company to manufacture microspheroidal cracking catalysts on a commercial scale.

1948... Cyanamid expands production of MS catalyst at Ft. Worth in anticipation of growing demands.

1951... Cyanamid builds new MS plant at Michigan City, Indiana, as refining demands continue to grow.

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Houdriflow Unit, Shamrock Oil & Gas Corporation.

tion section. The primary flash tower bottoms are charged in a once-through operation through a visbreaker heater to the visbreaker flash tower. The vapors from the visbreaker flash tower join those from the primary flash tower to make up the total reactor charge.

The unit produces approximately 52 percent of 420° F. e.p. gasoline based on the fresh reactor charge. Conversion levels are on the order of 70 percent. Natural clay catalyst, manufactured by Filtrol Corporation, is circulated in the unit at rates upwards of 200 tons per hour. Catalyst make-up requirements currently average three tons per day.

The unit initially was put on stream in March, 1951, and since that time has operated continuously except for a few isolated offstream periods of short duration caused by the failure of plant utilities and pumping equipment. The local management has repeatedly stated its gratification with the performance of the unit on these occasions in that the situations were easily brought under control with a minimum of manpower, a feature of particular importance to refiners not possessing large technical staffs. Of even more importance, however, is the fact that the unit was capable of handling its full design thruput within a few minutes following restoration of utilities.

In addition to the high degree of flexibility originally built into the unit, the reactor was also designed so that future revisions to accommodate a partial or total liquid reactor feed could be made with a minimum expenditure.

Shamrock Oil and Gas Corporation, Sunray, Texas

The Shamrock Houdriflow unit went on stream in the spring of 1951. The initial operation was smooth and within a few days the operating duties were reduced to a simple routine.

The unit was designed to charge 5900 BPSD of vacuum gas oil from Hutchinson-Moore Crude along with 5100 BPSD of recycle gas oil for a total of 11,000 BPSD. However, a shortage of feed stock has, to date, limited the fresh charge to approximately 4500 BPSD; a 1:1 recycle ratio has been maintained in order to produce a minimum of catalytic gas oils. At these rates the conversion level has been about 80 vol. percent with more than 60 percent of the fresh feed converted to a debutanized 420° F. e.p. gasoline. Research octanes have averaged 88.6 clear and 96.5 with 3.0 cc of tetraethyl lead. A product analysis while cracking on Filtrol clay catalyst is shown in Table 4.

California Refining Company, Perth Amboy

The latest Houdriflow installation to go on stream is the twin-unit plant of California Refining Company at Perth Amboy, N. J. These units are the largest in current operation, having a combined design charging capacity of 25,000 BPSD. Carbon burning capacity of the kilns is 20,000 pounds per hour, each kiln having three countercurrent burning zones. The combined design catalyst circulation rate is 850 to 1000 tons per hour, depending upon the stock being processed. Vacuum gas oils from both domestic and foreign crude oils are charged to the cat crackers, the sulfur content of some of the gas oils being as high as 2.0 weight percent. All of the equipment has been provided with the necessary alloy protection so that sour stocks may be processed in any of the equipment as desired.

The first of the twin Perth Amboy units went on stream on April 15, 1951. This unit was loaded with synthetic chrome bead catalyst. Within 24 hours, the charge rate had been increased up to and beyond the design rate of 12,500 BPSD. The second unit

TABLE 4

Shamrock Houdriflow Yields

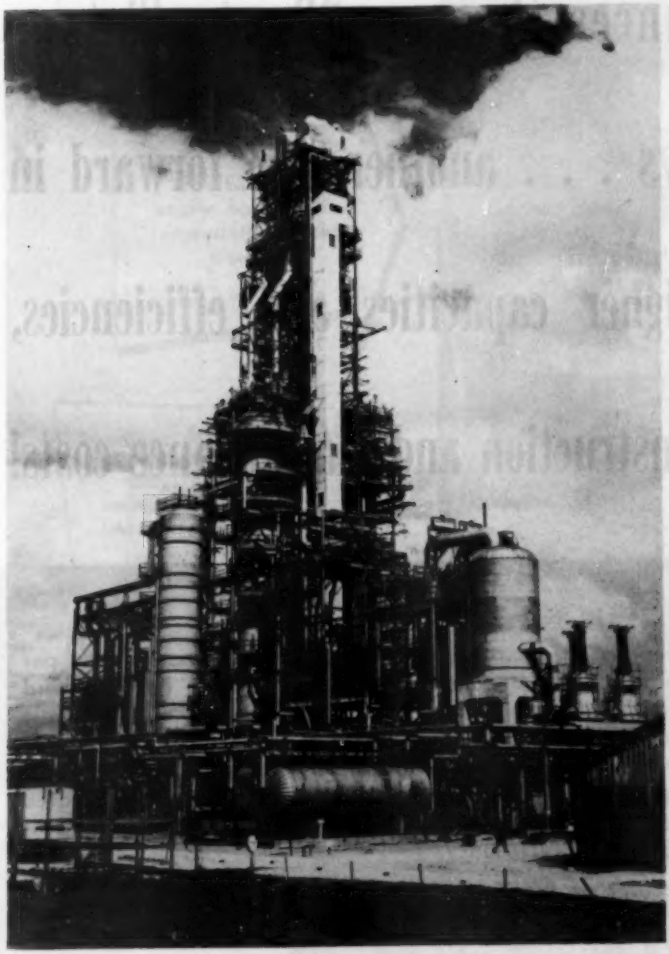
CHARGE	BPSD	°API	Lbs./Hour	Volume Percent	Weight Percent
Fresh Feed	4200	32.6	52,773	100.0	100.0
Recycle Gasoil	4200	31.7	53,060		
	8400	32.0	105,833		
PRODUCTS					
C_2 and Lighter	....	....	1,992	....	3.9
C_3's	306	....	2,304	7.3	4.4
C_4's	714	....	6,088	17.0	11.5
Gasoline—420° F. End Point	2705	59.7	29,166	64.4	55.2
Light Gasoil	521	31.0	6,613	12.4	12.5
Heavy Gasoil	200	26.5	2,610	4.8	4.9
Coke	....	....	4,000	....	7.6
	....	....	52,773	....	100.0

was placed into operation on May 9, 1951. One of the unique features of the latter operation is that this was the first commercial moving-bed catalytic cracking unit to utilize pelleted Filtrol SR catalyst. Despite the likelihood of problems associated with the first commercial use of a new catalyst, the unit went on stream without difficulty and continues to operate satisfactorily.

This installation provides another demonstration of the flexibility of the Houdriflow process in that the two units are loaded with different types of catalyst but must be capable of processing interchangeably the gas oils that are derived from the several crudes that are processed in the refinery. The charge to the Houdriflow units consists of 26° API vacuum gas oils with a boiling range of 500° F. to 1000° F. + endpoint. Depending upon the crude source, the sulfur content of the Houdriflow charge stock varies from about 0.5 to 2.0 weight percent and the Conradson carbon varies from about 0.5 to over 1.0 weight percent. The normal processing schedule at the refinery calls for changing the type of gas oil fed to a given reactor every few days. These changes have been made without any difficulty and it is not necessary to compromise on any operating conditions because of the differences in the catalyst in the two units. The charge for both Houdriflow units is preheated in a common furnace but with separate parallel passes to about 750° F. and then introduced directly into the cracking reactors through the Houdriflow liquid feed system. Under these conditions, the charge stock is almost entirely liquid when introduced into the reactor.

Other Houdriflow Units

Currently, other Houdriflow units are being engineered and constructed, which units will incorporate the most desirable features proven by the operation of the ten units described above. The new units all are designed capable of charging heavy liquid oil feed directly to the reactor and to operate with very low catalyst attrition rates.



Houdriflow Unit, Sun Oil Company, Toledo, Ohio.

UOP Fluid Catalytic Cracking Process

Universal Oil Products Company

THE UOP FLUID Catalytic Cracking process, licensed by Universal Oil Products Company, is adaptable to the needs of large and small refiners. Units designed in capacities ranging upward from 1500 barrels a day can be built and operated at costs comparing favorably with the cost of thermal cracking units of comparable capacity. A total of 13 UOP designed units has been placed in operation since 1947 and 12 additional units are now under construction.

The process is flexible both as to charging stock and products. It can successfully crack kerosine, light or heavy gas oil, and some types of reduced crude. The process produces gasoline of a different character from that produced by thermal cracking. It can be operated to produce either aviation gasoline, high-grade motor gasoline, or raw materials for the production of chemicals and synthetic rubber.

The latest type unit can utilize either synthetic or natural catalyst. In its most simple design, synthetic catalyst which has a microspherical form is used. Because of the spherical shape of the particle and its greater strength as compared with the ground powdered catalyst used during the war,

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Koch announces the new "Benturi" type Kaskade trays . . . another step forward in simplicity, higher capacities and efficiencies, *plus* lower construction and maintenance costs!

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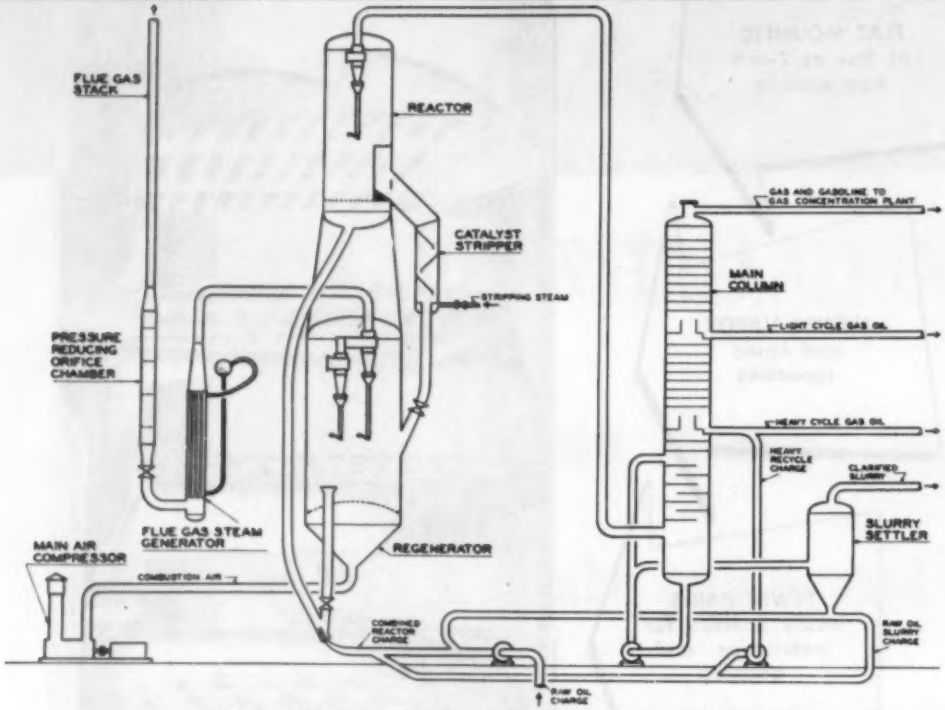

Figure 4. UOP Fluid Catalytic Cracking Process. (Courtesy, Universal Oil Products Company.)

this catalyst has very low erosion and attrition rates. In addition, the microspherical catalyst is much more uniform in particle size than the ground catalyst. Experience has shown that the catalyst makeup rate for replacement of losses and maintenance of activity in a number of commercial units is as low as 0.2 to 0.3 pound of catalyst per barrel of fresh charge stock.

Principal modifications in the new improved unit as compared with the earlier design are listed here:

1) In the small-size units the reactor and regenerator have been combined in a single tower which is erected as a self-supported column. The heavy structure required in the earlier units has been eliminated.

2) The large regenerator riser has been eliminated and the regenerator standpipe has been considerably shortened. There have been a general reduction and simplification of small piping.

3) The stripper has been modified to reduce entrained hydrocarbons in the catalyst passing into the regenerator.

4) The air supplied for combustion passes through the regenerator countercurrent to the catalyst. This permits multistage stripping and more complete utilization of oxygen.

A simplified flow diagram of the UOP fluid catalytic cracking process is shown in Figure 4. Typical results of operation on a 31° API mid-continent gas oil is given in Table 5.

TABLE 5

UOP Fluid Catalytic Cracking Process Results; Fluid Catalytic Cracking 31° API Mid-Continent Gas Oil (Silica-Alumina Catalyst)

OPERATION	Once-Through	Recycle
Conversion, percent	60	75
Yields, volume percent debutanized gasoline	45.0	53.0
Cycle Oil	40.0	25.0
Butylenes	5.8	7.1
Butanes	8.7	9.4
Propylene	5.2	6.4
Propane	2.4	3.2
C_5 and Lighter Gas (weight percent)	2.5	3.1
10-Pound RVP Polymer Gasoline	8.0	9.9
10-Pound RVP Catalytic Gasoline	47.4	55.8
Total 10-Pound RVP Gasoline	55.4	65.7
Octane Numbers of 10-Pound Catalytic Gasoline:		
Motor Method, Clear (F-2)	81.8	81.8
3 cc TEL per Gallon	86.6	87.4
Research Method, Clear (F-1)	93.7	94.2
3 cc TEL per Gallon	98.7	99.1

ORTHOFLOW Fluid Catalytic Cracking

The M. W. Kellogg Company

ORTHOFLOW FLUID catalytic cracking is The M. W. Kellogg Company's latest contribution to the development of the Fluid process. The accompanying closeup of the nearly completed converter and the diagram, Figure 5, show some of the construction and internal details of the world's first Orthoflow Fluid catalytic cracker, recently put on stream at Edmonton, Canada, for British American Oil Company, Ltd., by The M. W. Kellogg Company, New York. The unit, designed by the American firm, was erected by its subsidiary, The Canadian Kellogg Company, Ltd.

A small unit in comparison with the 45 or more familiar side-by-side Fluid crackers which Kellogg has engineered and erected, this Orthoflow is designed

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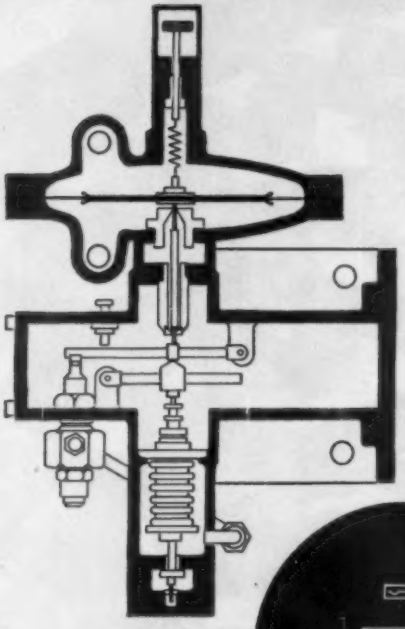
...like transforming 0-5″ w.c. to 3-15 p.s.i.



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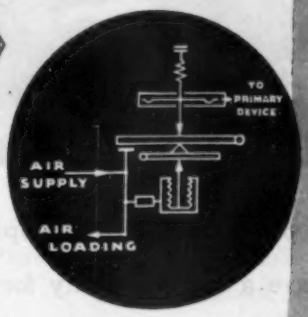

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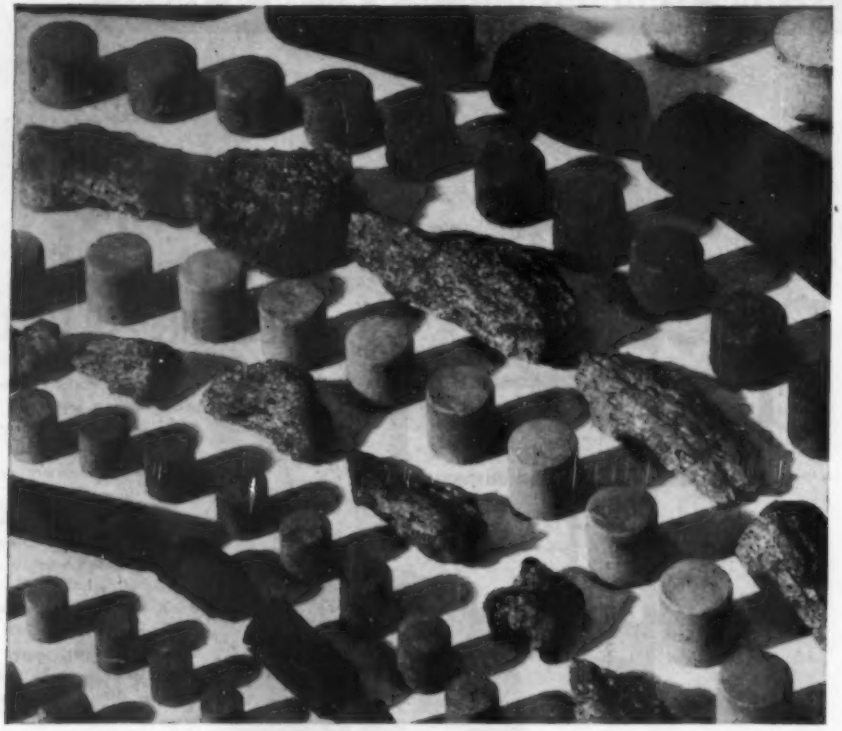

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TYPICAL CATALYSTS

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Boron Trifluoride
Boron Fluoride Addition Compounds
Hydrogen Chloride Anhydrous
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to process about 2000 barrels per day. The Orthoflow design, however, is not restricted to small throughput. Kellogg is currently building two more with capacities of over 8000 barrels daily and has designed, for the purpose of engineering study and cost comparison, units capable of processing more than 60,000 barrels daily. From these studies there are no apparent mechanical or process limitations which would restrict the usage of this type of design. And the cost picture naturally improves in larger installations.

Aside from the fact that the Orthoflow is a single-vessel unit containing chambers for reaction, regeneration and stripping, the most important design innovation is the straight-line catalyst carrier lines which are within the vessel. These lines will be much less subject to erosion by high velocity catalyst than bent lines. Another economy and low-maintenance feature of the design is the elimination of expansion joints in the lines.

To absorb the natural thermal expansion of the carrier lines, the specially designed catalyst-and-oil-flow

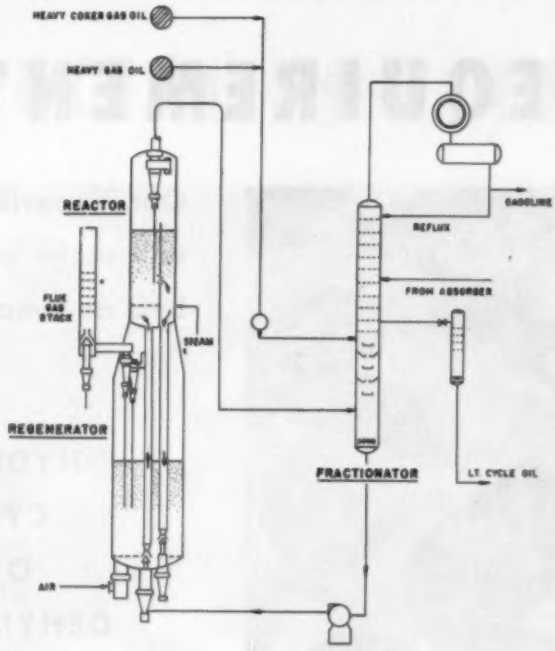
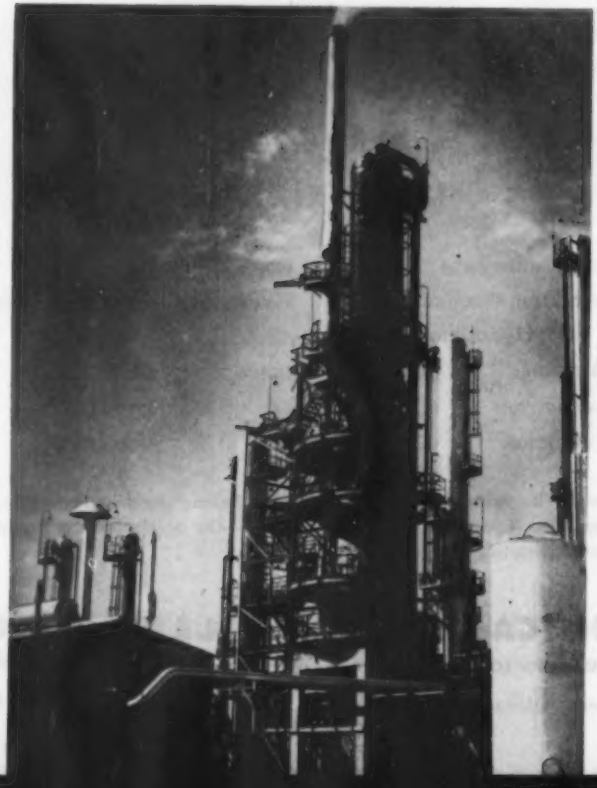


Figure 5. Simplified Flow Diagram of Orthoflow Fluid Catalytic Cracking Unit. (Courtesy, The M. W. Kellogg Company.)



World's First Orthoflow Catalytic Cracker Designed by The M. W. Kellogg Company for British American Oil Company, Ltd., Edmonton, Canada.

control valves are spring-loaded. The valves themselves are quite a deviation from the slide valves which control the flow in the majority of Fluid crackers erected to date. In essence, they are large needle valves through which catalyst and oil are introduced to the carrier line leading to the reactor. Hot catalyst from the bottom of the regenerator is drawn into the line by the pressure drop created by high velocity oil passing through the valve.

Another advantage of the Orthoflow design is the elimination of much of the supporting structure for the reactor and regenerator. This allows a considerable saving in steel work and reduces the over-all space required for the unit. In addition, all control points, particularly the valves for control of catalyst flow, although normally automatic, are low enough to be easily accessible to operating and maintenance crews.

By and large, the Orthoflow reflects an increased tendency on the part of refiners to seek lower investment costs and in addition, possesses those design features which serve to lower maintenance costs.

Many New Catalytic REFORMING Processes Now Available

WITHIN THE PAST year four new catalytic reforming processes have been announced. Such active interest in reforming is stimulated by the need for reforming low-octane naphthas and straight-run gasolines into high quality components more suitable to meet the new demands for high-octane gasolines. The new reforming processes are all catalytic and utilize either a non-regenerative fixed catalyst bed, or a regenerative moving or fluidized bed. The yield-octane results obtained represent considerable improvements over previous reforming processes. In addition, investment and operating costs are distinctly more attractive. A substantial number of new reforming units have been or are being built, and many others are currently in the design stage.

PROCESSES for the octane number improvement of petroleum fractions in the gasoline range are currently of great importance. One of the reasons for this is the greatly increased demand for all petroleum products, and especially fuels for internal combustion engines. Another reason is the demand for automotive fuels of higher and higher knock ratings.

Through the years there has been a continuous increase in the octane demands for automotive fuels due to the continually higher compression ratios used in automotive engines. However, as of late, there has been a considerable further increase in compression ratios, and the octane requirements of motor fuels has reached a new high.

Of course the installation of more and more catalytic cracking capacity has gone a long way toward solving the refiner's quality fuel problem. However, there is a limit as to how far catalytic cracking can raise the average knock rating of the entire refinery output of gasolines. This is due to the fact that total gasoline output from refining operations consists of a considerable portion of virgin naphthas of low octane number. Thus the problem of increasing the octane ratings of the entire gasoline output ultimately becomes the problem of how to increase the knock ratings of the natural and straight-run gasolines which are blended into motor fuels.

The virgin naphthas have low octane numbers because they contain naphthenic and straight-chain hydrocarbons. The aromatic content is usually negligible, and if there are any isomeric aliphatic hydrocarbons present, they are only very slightly branched in chain. Thus the reforming necessary to improve octane number consists chiefly of aromatization and isomerization, and all of the reforming processes have these reactions as their chief goal.

Demand for Aromatics

Another reason for the high current interest in catalytic reforming is due to the shortage of benzene and aromatics. The demand of all aromatics, and especially benzene, has been increasing phenomenally, while the conventional supply from coking operations has had no hope of keeping pace. In the face of such an unprecedented demand for aromatics, it is only natural to turn to petroleum as a source of supply of additional amounts of these materials. By means of the new catalytic reforming processes it becomes possible to convert naphthenes in natural and straight-run gasolines to aromatics.

One of the first catalytic reforming processes was hydroforming. Immediately preceding and during World War II there were a total of seven hydroforming units built. Most notable of the hydroformers was the tremendous unit built during the war at the Baytown Ordnance Works in Texas. This was a major contributor to the nation's toluene supply.

The hydroforming operation is characterized by cyclic operation. The typical unit includes four reactors, two of which are on-stream and two in various stages of regeneration at any one time. The cycle sequence is usually controlled by motor-operated valves with a time cycle controller. The conversion is accomplished at temperatures of 900-1000° F. and pressures of 150-300 psig with a high partial pressure of hydrogen in the reaction zone. In order to recycle a hydrogen-rich stream, it is necessary to employ an enrichment operation. Regeneration is accomplished with air, and heat recovery is effected with waste heat boilers.

Although the hydroforming process was very successful, and filled a definite need, it has given way to a number of new improved catalytic reforming processes. These new developments offer savings in both investment and operating costs, as well as improvements in the octane-yield relationship. These advantages, coupled with the increased demand for reforming predict a great deal of activity in the field in the coming years.

The new catalytic reforming processes may be classified into two main categories: 1) those which employ a non-regenerative, but comparatively expensive catalyst, and 2) those which use a regenerative, but cheap catalyst. However, even in the case of the regenerative catalyst, the improved designs have reduced the equipment and costs of regeneration to a minimum. All the new processes are highly-selective in regard to the reforming reactions, and produce a hydrogen-rich gas suitable for recycle by simple phase separation. Furthermore, the catalysts employed permit operation at high severity in order to provide high octane gains, while still holding cracked gas formation to a minimum.

The exact prediction of the economics of any proposed installation depends on an accurate forecast of the market for the prices of both the charging stock and the product over the period of the life of the plant, which is obviously impossible. However, certain generalizations, believed to be accurate, can be made:

"1) The present trend to emphasize quality will continue. This will result in an increasing differential between the values of charge and of product.

"2) The refiner who operates the process which can produce the highest quality product will be best able to survive in a competitive market.

"3) The process which has the better yield-octane relationship will have the better economic advantage."[2]

Presented in the following sections are descriptions of the most publicized of the new catalytic reforming processes. There are other catalytic reforming processes in addition to these, but the attempt here is to review only those which utilize hydrogen recycle under conditions of high severity for high octane number gains.

U.O.P. Platforming

U.O.P. PLATFORMING was the first new postwar catalytic reforming process to be placed in commercial production. Developed and licensed by Universal Oil Products Company, Chicago, Platforming is a continuous catalytic reforming process by which straight-run and natural gasolines are reformed to produce fuels of high knock ratings and lead susceptibilities. The process can also be used to convert selected naphtha fractions into aromatics, including benzene, toluene, and xylenes. The process is very flexible, in that a plant which operates for the production of motor fuel can operate equally well for aromatics production. The name Platforming is derived from reforming over platinum containing catalyst.

One of the principal reactions involved is the dehydrogenation of naphthenes to aromatics. Straight-run and natural gasolines usually contain substantial amounts of naphthenes of the five and six-membered ring types, which are especially suitable for conversion. Cyclohexane, for example, is dehydrogenated to benzene, and methylcyclohexane, to toluene. A unique feature of the platinum containing catalyst is that five-membered rings are converted to six. For example, dimethylcyclopentane is isomerized to methylcyclohexane, which is dehydrogenated to toluene. During dehydrogenation a large amount of heat is absorbed, and three mols of hydrogen are liberated for each mol of naphthene aromatized.

Simultaneous to the dehydrogenation of naphthenes, three types of reactions occur involving paraffins. One of these is hydrocracking, wherein high-molecular weight paraffins are cracked to lower molecular weight paraffins. At the same time, hydrogenation occurs, with some of the hydrogen liberated in the dehydrogenation absorbed to keep the cracked products saturated. Hydrocracking is an exothermic reaction, but the rate is much slower than for dehydrogenation. Also there occurs an isomerization of the paraffinic hydrocarbons with the production of highly-branched chain types. Finally, there is a certain amount of dehydrocyclization of paraffins to aromatics.

In addition to the hydrocarbon conversion reactions above, the catalyst effects desulfurization of sulfur compounds in the feed to produce hydrogen sulfide. The sulfur content of the Platformed gasoline is normally 0.005 percent or less, with little effect of the sulfur content of the feed stock. Since the Platformer product is saturated and essentially free of oxygen, sulfur, and nitrogen compounds, storage stability is outstanding.

The first commercial Platforming unit placed in operation was for Old Dutch Refining Company at Muskegon, Mich., in October, 1949.[8] Since that time the process has attracted wide interest, and 21 additional units have been licensed, six of which are now on stream.

Figure 1 presents a simplified flow diagram of a typical Platforming unit for motor fuel production. The unit may be divided into three sections: a feed-preparation section, a reactor section, and a stabilization section.

The feed-preparation section consists of a fractionation column taking material boiling in the gasoline range and removing overhead any light gasoline that need not be charged to the reaction zone by virtue of its high octane number. A small amount of bottoms is removed to prevent high boiling material from reaching the catalyst. The reactor charge is drawn from the column as a sidecut. In many cases, existing facilities permit use of a simpler feed-preparation system.

The reactor section consists of preheaters for the reactor feed and recycle gas, beds of catalyst, intermediate heaters between catalyst beds, heat exchangers, a product separator drum, and a recycle gas compressor. Catalyst is divided into two or more beds in series depending on the severity of the operation and on the type of feed stock, with interheating between beds of catalyst, as the over-all reaction is endothermic.

Reactor feed stock from the feed-preparation section is pumped to the feed-product exchanger. The recycle gas joins with the naphtha ahead of the exchanger system and the combined stream is then heated in the same coil. The reactants are reheated

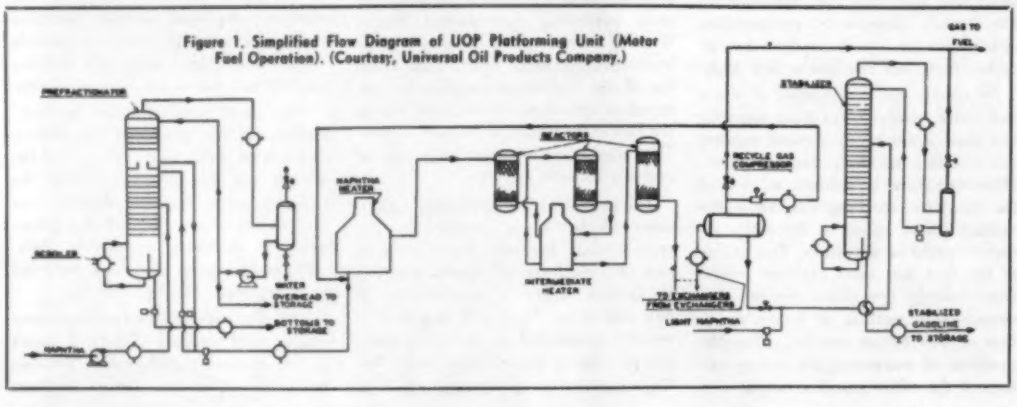


Figure 1. Simplified Flow Diagram of UOP Platforming Unit (Motor Fuel Operation). (Courtesy, Universal Oil Products Company.)

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TABLE 2
UOP Platforming Various Straight Run and Recycle Distillate Naphthas for Aviation Fuels. Properties of Charge and Yields.

Charge Stock to Reactors Source	Coastal St. Run	Coastal St. Run	Redwater St. Run	Coastal Recycle Dist.	E. Texas St. Run
Vol. percent of Original St. Run	....	23.5	30.9	....	....
Vol. percent of crude or recycle Distillate	5[a]	6	28	41.4	20.0
Gravity, °API	57.4	60.0	54.3	65.1	57.3
Composition, Vol. Percent:					
Paraffins	31	37[b]	41	56	43
Naphthenes	61	57[b]	52	39	51
Aromatics	8	6[b]	7	5	6
Total	100	100	100	100	100
D-86 Distillation:					
IBP °F	203	188	186	156	193
10 percent	206	193	212	171	206
50 percent	206	197	268	182	236
70 percent	209	200	312	192	259
90 percent	212	206	362	208	296
EP °F	220	213	402	226	334
Octane Ratings:					
F-1 Clear	....	67.3	51.5	....	57.9
F-1 + 3 cc TEL/gallon	....	83.6	66.2	....	77.6
Yields Percent of Charge to Reactors:					
Hydrogen, weight percent	2.4	2.6	1.6	2.0	1.9
Methane, weight percent	0.4	0.2	0.6	0.5	1.5
Ethane, weight percent	1.7	0.8	1.4	1.6	1.2
Propane, weight percent	4.2	1.9	3.0	3.3	2.8
Isobutane, weight percent	2.4	1.8	1.5	3.1	1.4
n-Butane, weight percent	1.5	1.1	2.3	2.3	1.9
Isopentane, weight percent	1.3	1.5	2.3	2.1	2.9
n-Pentane, weight percent		0.5	1.1		2.3
Light Platformate, Vol. percent	38.0	36.0[c]	61.9[d]	39.5	79.3[c]
Heavy Platformate, Vol., percent	51.3	28.0	30.9	29.7	1.4

[a] Approximate. [b] Weight percent. [c] 84.0 vol. percent including pentanes and 79.3 vol. percent depentanized. [d] Depentanized.

TABLE 3
UOP Platforming Various Straight Run and Recycle Distillate Naphthas for Aviation Fuels. Properties of Products

Charge Stock Source	Coastal St. Run	Coastal St. Run	Redwater St. Run	Coastal Recycle Dist.	E. Texas St. Run
Boiling Range, °F	203-220	186-213	186-402	186-236	193-336
Light Platformate:					
Gravity °API	69.7[a]	69.2	64.1	64.0[d]	60.0[d]
Reid Vapor Pressure, lbs.	.....	2.1	2.4	6.1	3.0
D-86 Distillation:					
IBP °F	114	171	160	140	147
10 percent	150	177	168	150	154
50 percent	195	185	223	159	230
70 percent	203	191	246	167	259
90 percent	214	200	274	183	302
EP °F	225	211	300	209	337
Octane Ratings:					
F-1 clear	.....	.....	.....	.....	89.6
F-1 + 3 cc TEL/gallon	.....	.....	.....	.....	98.2
F-3 + 4.6 cc TEL/gallon	.....	88.8	92.4[c]	96.0[c]	98.0[c]
F-4 + 4.6 cc TEL/gallon	.....	96.5	isoCa + 0.15[c]	isoCa + 1.25[c]	isoCa + 1.1[c]
Benzene content, vol. percent	2.6	13.6	.....	19.6	.....
Toluene content, vol. percent	23.1	9.0	.....	2.3	.....
Heavy Platformate:					
Gravity °API	32.9	32.0	30.9	32.7	29.2
D-86 Distillation:					
IBP °F	227	226	206	228	.....
10 percent	231	230	214	234	.....
50 percent	236	232	250	238	.....
70 percent	242	234	260	243	.....
90 percent	263	241	292	264	.....
EP °F	354	314	380	350	.....
Octane Ratings:					
F-3 + 4.6 cc TEL/gallon	isoCa + 0.50	isoCa + 0.53	.....	.....	.....
F-4 + 4.6 cc TEL/gallon	>+6	>+6	.....	.....	.....
F-1 clear	.....	.....	99.8	.....	.....
F-1 + 3 cc TEL/gallon	.....	.....	isoCa + 0.15	.....	.....
Toluene content, vol. percent	51.0	92.3	.....	82.0	.....
Xylenes and Ethyl Benzene, vol. percent	13.0	3.4	.....	15.0	.....

[a] Calculated to include pentanes produced and sealed from 4.0 cc TEL/gallon data. [b] Obtained on a blend of proportionate parts of light and heavy Platformate + 15 percent isopentane. [c] Determined on blend of 78 percent debut. light Platformate and 22 percent isopentane (7.1 # Rvp. blend.) [d] Including a portion of the pentanes produced.

between catalyst beds by an intermediate heater or heaters. After heat exchange, the reaction products flow to a separator drum from which the recycle gas compressor takes suction. The net make of gas goes to fuel. Liquid product from the separator drum passes to a stabilizer for preparation of a finished gasoline.

The stabilization section consists of a high-pressure stabilizer for production of a finished gasoline of desired vapor pressure from the bottom of the column. Gas from the stabilizer reflux drum enters the absorption system or fuel system as is desired. No rerunning of the stabilizer bottoms is necessary since no high-boiling products are made.

Straight-run gasoline fractions in the 180-400° F. boiling range are suitable charge stocks. Similar fractions of many cracked gasolines may be added to the straight-run charge, in which event the product will be essentially the same as that derived from straight-run naphtha alone. In view of the fact that the lower boiling fraction of thermally cracked gasoline, that is the material boiling below about 200° F., is a good fuel from the standpoint of octane number, it is desirable that only the higher boiling fraction of thermally cracked gasoline be included in the charge to the Platformer.

At the Muskegon unit,[4] the conversion reaction is carried out at 700-750 psig, as provided by pumping liquid feed with plunger pumps. Owing to the net endothermic effect, the temperature falls on passage through the reactors, but the inlet gas to each is maintained at about 900° F. by means of the reheaters. The reactor effluent is condensed under full pressure at 100° F. The recycle gas contains about 85 percent hydrogen.

Typical results for the Platforming operation for improving motor fuel are given in Table 1. For the production of aviation fuel components, recent results obtained in both pilot plant and commercial platforming operations are given in Tables 2 and 3.[4]

In the Platforming operation there are four major operation variables. These are temperature, space velocity, pressure, and hydrogen recycle rate. The effects of these variables for various charging stocks have been determined and are available.[3]

TABLE 1
Platforming of Mid-Continent Straight-Run Gasoline

	Yield, Percent of Full Range 400° F. E.P. Charge				F-1 Octane Numbers	
	RVP	Vol. Percent	Weight, Percent	B/D	Clear	+3cc TEL
Prefractionation:						
Charge (full range 400° F. end point)	4.5	100.0	100.0	1000	69	69
Products:						
Light straight-run	21.4	11.8	9.8	118	....	....
200-400° F. Platformer charge	1.0	88.2	90.2	882	....	....
Platforming products, percent of prefractionator charge:						
C_3 and lighter	....	....	8.3	....	....	....
C_4-plus Platformate	....	83.5	81.9	835	....	....
Blend of Light Straight-Run and Platformate:						
Light straight-run component	....	11.5	9.8	118	....	....
C_4 plus Platformate component	....	83.5	81.9	835	....	....
Total Blend	10.0	95.3	91.7	953	87.5	97.0

Benzene Shortage

Considerable attention has been directed toward the possibilities of large-scale production of benzene and other aromatics from petroleum raw materials by the Platforming, as well as other reforming processes. These developments are motivated by the current benzene shortage, which is expected to grow progressively worse in the future. For example, the U. S. demand for benzene is predicted to rise from 252 million gallons in 1951 to

411 million gallons in 1955. On the other hand, the production of benzene from present sources (chiefly coking operations) is not expected to rise substantially from the 1951 estimate of 225 million gallons. In the face of such serious potential shortages, it is only logical to look to the petroleum industry for a source of raw materials for the production of benzene and higher aromatics, and rather thorough studies have been made of the application of Platforming to this problem.[4]

The production of benzene from petroleum raw materials by Platforming is based on the fact that in the presence of the platinum containing catalyst the C_6 naphthenes, cyclohexane and methylcyclopentane, are converted to benzene with yields ranging from 75 to 92 percent of the theoretical.

It has been estimated that the C_6 fraction for straight-run gasolines contain from 20-55 percent of the C_6 naphthenes, as well as 1-9 percent natural benzene. Natural gasolines also contain considerable quantities of these components. On the basis of the 1949 published figures on the total U. S. production of straight-run and natural gasolines, estimates have been developed of the potential benzene production by Platforming all available stocks. Taking into account estimated feedstock compositions and expected yields, the potential production of benzene from straight-run and natural gasoline was estimated at 700 million gallons per year. Concurrent with these operations, it was estimated that there would be a potential production of 1600 million gallons of toluene, and 2000 million gallons of xylenes and ethylbenzene.

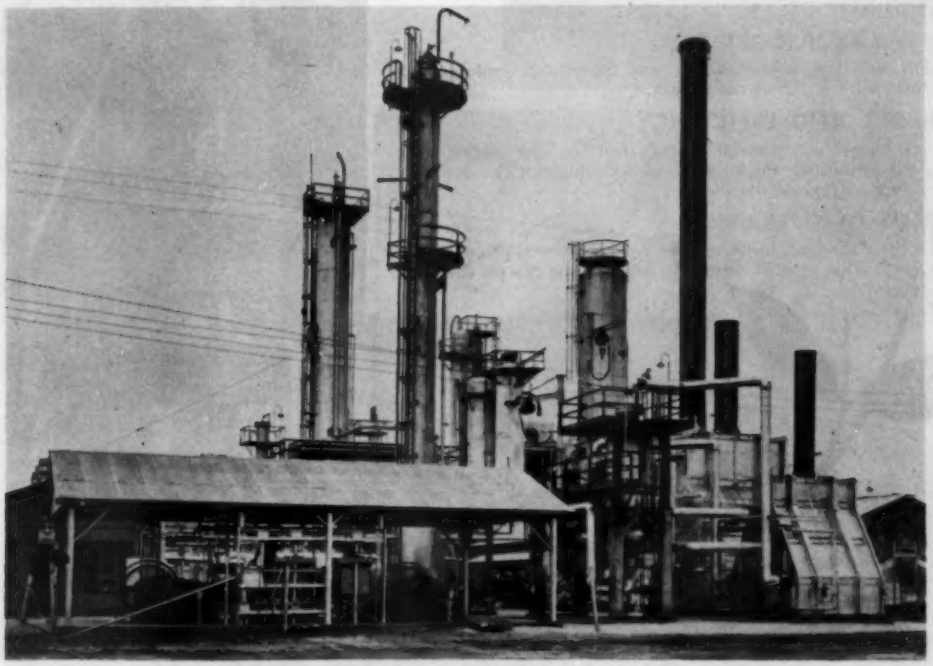
The above estimate of 700 million gallons of benzene is a tremendous amount, but it is not out of the question to consider the possibility of producing something of the order of 200 million gallons of benzene per year from petroleum in the not-too-distant future. This is made more evident by the fact that, on the basis of 200 million gallons of benzene a year, the diverted amount of gasoline production would amount to only about one-half of one percent of our total gasoline production.[4]

The Atlantic Catalytic Reforming Process

THE ATLANTIC CATALYTIC REFORMING process, announced early this year, employs a new catalyst developed by The Atlantic Refining Company, Philadelphia. The process has been demonstrated by more than a year's operation of a pilot plant, and the company is now building a full-scale plant at its Philadelphia refinery to commercially utilize the new process.

The Atlantic reforming process is a catalytic process for the conversion of low-octane naphthas into finished high-octane gasoline. In addition, this process is capable of producing substantial quantities of highly concentrated aromatic streams. Charge stocks to the process may consist of any fractions of crude naphtha up through normal gasoline end point, natural gasolines, and mildly thermally cracked naphthats. The catalyst employed does not require special rerunning facilities immediately preceding the reaction section. Sulfur and normal water concentrations are not permanent poisons, but temporarily affect the activity level of the catalyst as a function of their concentration. For the production of

General View of Old Dutch Platforming Unit Located at Muskegon, Mich. (Courtesy, Universal Oil Products Company.)



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Confirmation of the above may be had by placing a telephone call to Mr. M. H. McMurrey, President, McMurrey Refining Company, Tyler, Texas.

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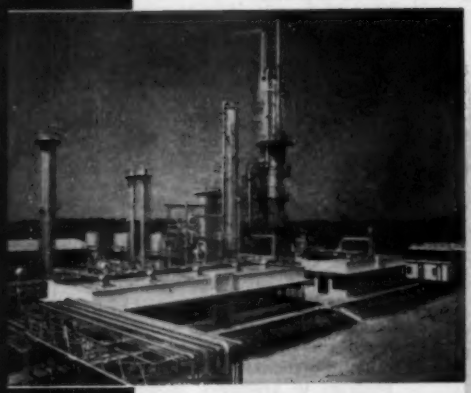
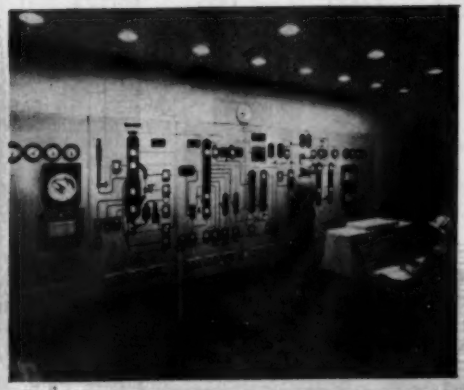
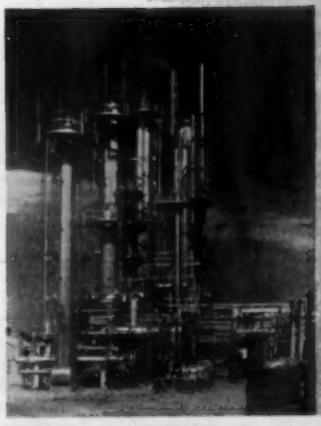




Mr. M. H. McMurrey, President, McMurrey Refining Company, is a well-known East Texas Industrialist and Rancher. The progressive thinking and planning of Mr. McMurrey and the splendid cooperation of his staff made possible the completion of this refinery in record time.



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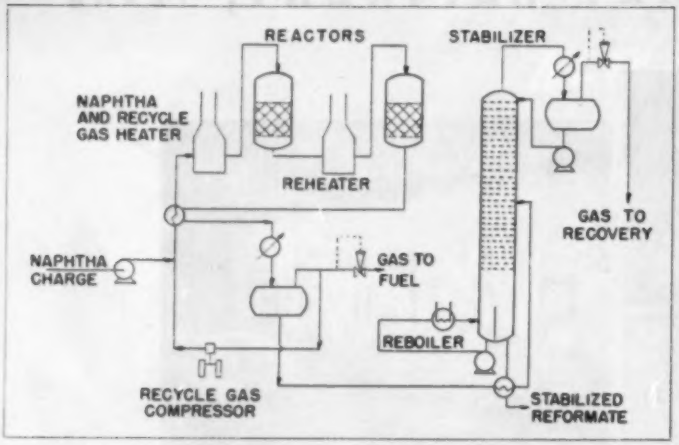


Figure 2. Simplified Process Flow Diagram—Atlantic Reforming Process. (Courtesy, The Atlantic Refining Company.)

aromatics and aviation blending stocks, it may be desirable to provide special prefractionation, depending on the method of aromatic purification selected.

Figure 2 shows a schematic flow diagram of the process. With the normally required operating conditions, this is a continuous, non-regenerative process in which the charge naphtha and a recycle hydrogen stream are passed over a pelleted catalyst at temperature of 850 to 1000° F. and pressures of 300-700 psig. The recycle hydrogen is of 95 percent purity.

The catalyst properties and operating conditions have been selected to yield an optimum combination of the desired isomerization and dehydrogenation reactions while minimizing undesired cracking reactions. The selectivity of the process is illustrated by the high purity of the hydrogen recycle gas and by the absence of substantial quantities of methane or other light hydrocarbons. In addition to the high yields obtained, the reformate is essentially free of sulfur and olefins such that no treating or rerunning of the stabilized gasoline is required.

TABLE 4
Motor Gasoline Production—East Texas Naphtha

	Charge	PRODUCTS I	II	III
API Gravity	55.9	52.1	51.7	50.7
RVP	1.0	2.6	2.7	3.7
ASTM Dist. 0	188	142	134	122
10	215	194	192	177
50	257	254	250	243
EP	373	382	370	385
CFRR Octane 0 cc.	54.5	73.6	79.8	85.0
3 cc.	74.3	90.8	93.7	94.3
Yields, Percent on F.F.:				
Vol. Percent C_5 plus	....	93.5	90.7	88.6
Wt. Percent H_2	....	1.37	1.49	1.75
C_1	....	.07	.10	.19
C_2	....	.12	.27	.45
C_3	....	1.18	1.96	2.75
Vol Percent C_4	....	2.28	4.27	5.20

Yield and quality data for motor fuel production from East Texas crude naphtha, a typical reformer stock, is presented in Table 4.[9]

Houdriforming

HOUDRIFORMING is the name given to a new catalytic reforming process developed and licensed by the Houdry Process Corporation, Philadelphia. Houdriforming is a catalytic process for reforming petroleum naphthas to aromatic concentrates and high octane gasoline. Dual-function catalysts have been developed for this process. These catalysts are very selective for 1) the dehydrogenation of C_6 ring naphthenes, 2) the dehydro-isomerization of alkyl cyclopentanes, and 3) the isomerization of normal and slightly branched paraffins into highly branched paraffins. Essentially no hydrocracking occurs and, therefore, substantially pure hydrogen (97 percent) is produced. The catalysts are not affected by sulfur compounds including thiophene. The process is nonregenerative, although for flexibility of operation and for protection in case of error in operation the catalyst can be regenerated in place.

Having been proved in the pilot plant, Houdriforming is soon to be placed in commercial operation. Plans are well under way for the construction of a 10,000-barrel-per-day Houdriformer to be erected at Sun Oil Company's Marcus Hook, Pa., refinery. This reforming unit is being designed expressly for the production of aromatics, and will be coupled with Sun's new Arosorb process for the separation and purification of benzene, toluene, and xylenes.

Upgrading of motor gasoline by Houdriforming is accomplished by five reactions:[5] conversion of six-membered ring naphthenes to aromatics, dehydro-isomerization of alkyl cyclopentanes to aromatics, isomerization of straight chain or slightly branched paraffins to highly branched paraffins, dehydrocyclization of paraffins to aromatics and desulfurization of naphtha which improves the lead response. The isomerization function of the catalyst for converting low octane paraffins to high octane branched chain paraffins is of great importance in attaining the high yield of high octane reformate.

Conversion of naphthenes to aromatics improves the octane rating only in the case of higher boiling naphthenes. Thus, the conversion of methyl cyclopentane and cyclohexane (F-1 blending value 107 and 110, respectively) to benzene (F-1 blending value 99) actually involves a loss of blending octane number, while the conversion of dimethyl cyclohexane to xylene increases the blending octane number from 68 to 145. In employing Houdriforming for motor gasoline production it is, therefore, desirable to use only feed stocks which have been fractionated to include the maximum amount of naphthenes in a boiling range in which octane improvements can be obtained.[5]

Shown in Figure 3 is a simplified flow chart of the Houdriforming process. Actually, the process is very simple, consisting essentially of a catalytic reaction section, a condensation and gas separation section, and facilities for the recycle of hydrogen. The reaction system consists of a number of fixed-bed reactors in series, with intermediate heaters to provide for the endothermic heat of reaction.

Ordinarily the process is nonregenerative. In catalyst life tests, the pilot plant unit has been in continuous operation for 30-50 days without regeneration or loss of catalyst activity. However, for most severe conditions

on unusually wide-boiling range charge, deposits may slowly accumulate on the catalyst. In such an event, the catalyst may be easily regenerated in place.

As an example of the application of Houdriforming for the production of high-quality motor fuel components, Table 5 gives the inspection of a typical naphtha charge stock. The results of the operation on this feed material at three sets of operating conditions are given in Table 6. These data illustrate how an increase in severity of operating conditions will raise the knock rating at the expense of the yield.[5]

TABLE 5
Inspection of Charge Stock for Gasoline Production
(East Texas Type Naphtha)

Boiling Range	188-366° F.
Gravity, °API	55.3
Distillation, ASTM:	
IBP, °F.	188
10 Percent	215
30 Percent	232
50 Percent	252
70 Percent	280
90 Percent	317
Dry Point	349
Sulfur, Percent	0.006
Composition:	
Paraffins, Vol., Percent	44
Olefins, Vol., Percent	0
Naphthenes, Vol., Percent	42
Aromatics, Vol., Percent	14
Octane Number: F-1 Clear	51.2
F-1+3 cc. TEL	76.6

TABLE 6
Houdriforming of East Texas Type Naphtha

	Condition I	Condition II	Condition III
Yield, C_5+, Vol. Percent of Feed	77.7	88.5	96.0
Weight Percent of Feed	82.8	92.7	96.0
C_4, Vol. Percent of Feed	17.2	6.1	1.2
F-1 Clear, 3 lb. RVP Gaso.	97.3	91	71
F-1+3 cc. TEL, 3 lb. RVP Gaso.	Iso-octane + 0.3 cc TEL	98	87
Yield, 10 lb. RVP Gaso. Calc., Vol. Percent	88*	98†	106‡
F-1 Clear, Calc.	98	92.5	75
F-1+3 cc. TEL, Calc.	>100	99	89.5

* Excess butane over 10 lb. RVP gasoline is 8.9 vol. percent.

† Outside butane required for 10 lb. RVP gasoline is 5.4 percent.

‡ Outside butane required for 10 lb. RVP gasoline is 8.8 percent.

TABLE 7
Inspection of Base Charge Stock for Aromatic Production

Boiling Range*	150-220° F.
Gravity, °API	60.2
Distillation, ASTM:	
IBP, °F.	162
10 Percent	180
30 Percent	186
50 Percent	190
70 Percent	196
90 Percent	204
Dry Point	215
Composition:	
Benzene	1.8
Toluene	4.2
Methyl Cyclopentane	5.1
Cyclohexane	14.3
Dimethyl Cyclopentanes	9.2
Methyl Cyclohexane	22.7
Paraffins	43.7

* Temperatures are the cut points during preparation of this stock using a 20 plate distillation column.

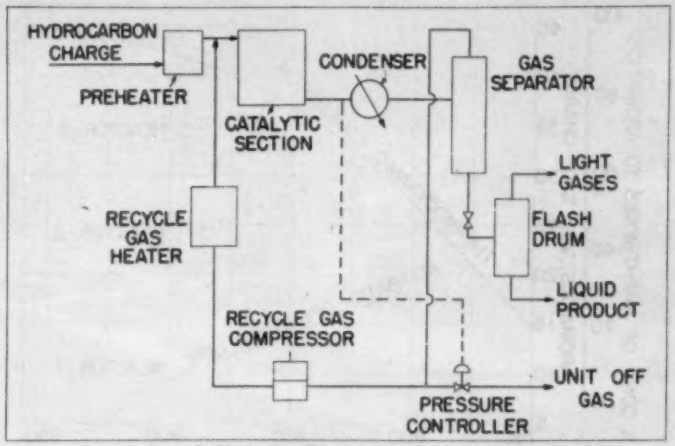


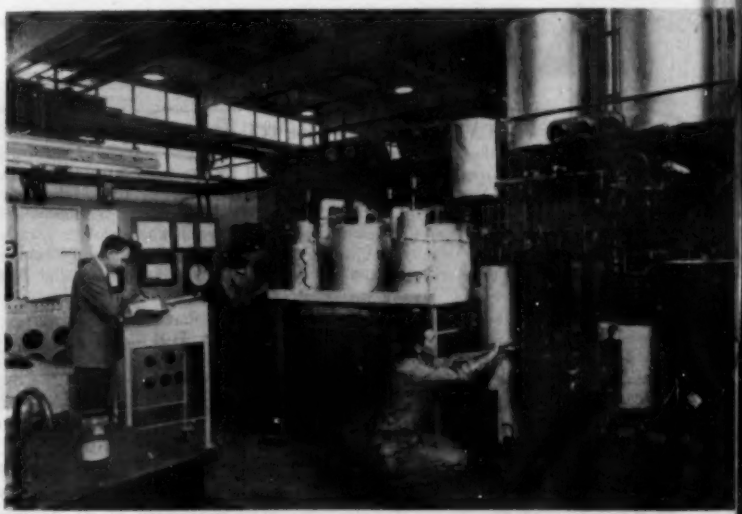
Figure 3. Simple Flow Chart of Houdriforming Process.

TABLE 8
Houdriforming Operations Processing a 150-220° F. East Texas Type Naphtha for Benzene and Toluene Production

	ORDER OF INCREASING SEVERITY		
	1	2	3
Liquid Product C_5-Free, Vol. Percent of Charge	93.2	92.2	91.5
Aromatics in Liquid Product, Vol. Percent	38	43	45
Conversion of Naphthenes to Aromatics, Percent	70	84	90
Unit Off Gas Produced, SCF per Bbl.	1100	1310	1360
Hydrogen Content of Off Gas, Vol. Percent	96.5	96	97.5

As an example of operation to produce aromatics, Table 7 presents a charge stock comprising a 150-220° F. cut of an East Texas type naphtha. The availability of naphthenes in this charge stock would allow a stoichiometric yield of 48.4 volume percent aromatics based on the charge, including the aromatics originally present in the charge. The results of Houdriforming this charge at three levels of severity are presented in Table 8.[5]

The maximum yields obtainable in adiabatic operation can be calculated on the basis of thermodynamic equilibrium, the heat of reaction, and the heat capacity of the reaction constituents. Dehydrogenation of naphthenes is highly endothermic and this heat is supplied by the sensible heat of the reaction constituents. A temperature-



Multibed Adiabatic Unit, Houdriforming Pilot Plant.

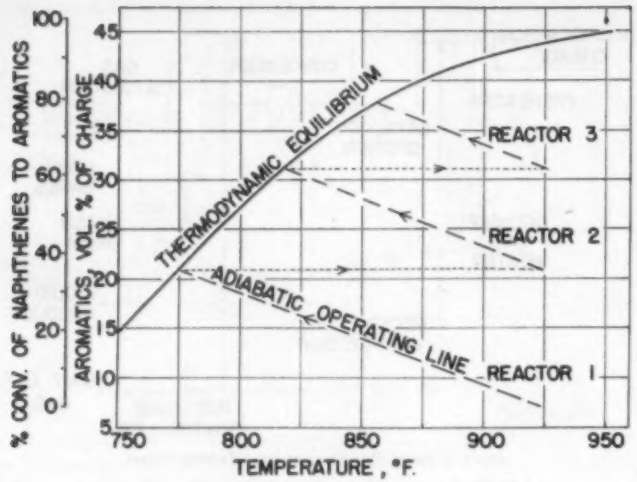


Figure 4. Adiabatic Operation of Houdriforming Unit.

conversion line can be calculated, starting at reactor inlet conditions of temperature and composition. When plotted on the same figure as the equilibrium composition, this line will intersect the equilibrium line at a point which then represents the maximum amount of aromatics obtainable in a single adiabatic reactor.

In order to obtain good ultimate yields with adiabatic reactors, it is necessary to utilize several reactors in series, with inter-heaters between. The advantages of this arrangement are best understood by a study of Figure 4. Here, in a typical operation involving three reactors in series, the charge to each reactor is introduced at 950° F. By means of the successive reaction stages, it is seen how a 35 percent conversion of naphthenes to aromatics in the first reactor is ultimately increased to 75 percent after passage through the third reactor.[5]

Thermofor Catalytic Reforming

THERMOFOR CATALYTIC REFORMING is the name given to a new catalytic reforming process developed by Socony-Vacuum Oil Company, Inc. As the name implies, the new reforming process is an outgrowth of the Thermofor catalytic cracking process. As in the TCC operation, the TCR process utilizes the moving catalyst bed technique, including a kiln for regeneration.

The TCR process differs from other recently-developed catalytic reforming processes in that it uses a low-cost chroma-alumina catalyst in bead form, which is very durable in order to withstand circulation. Some carbon is deposited during conversion so that regeneration is required. However, the catalyst recirculation rate in reforming is but a fraction of that required in the TCC process. The necessity of this small amount of regeneration is easily justified by the flexibility it gives the process. Thus the process can operate at higher reforming severities which means higher octane numbers for the reformed product and the process can handle heavier feed stocks and feed stocks which contain ends.

It is said that the yield-octane results for the TCR process are quite satisfactory. On a 50-barrel-per-day pilot plant, it has been found possible to reform certain 35 octane number naphthas to over 100 F-1 ratings with 3 cc TEL.

A 3000 barrel-per-day TCR unit is being designed by Socony-Vacuum for possible installation at its Augusta, Kan., refinery.

Fluid Hydroforming Process

FLUID HYDROFORMING is the recently announced catalytic reforming process for which licenses can be obtained from Standard Oil Development Company, The M. K. Kellogg Company, or Standard Oil Company (Indiana). "Fluid Hydroforming" is so called because it utilizes the highly-developed fluidized solids technique.

The new process has several advantages over the fixed-bed hydroformers built during World War II. In these earlier hydroformers, reaction beds had to be alternately taken out of production while the catalyst was regenerated. The new Fluid catalyst system continuously withdraws catalyst from the reaction zone and regenerates it simply and cheaply. Daily operating costs are expected to be approximately 30 percent lower than those of a fixed bed with the same capacity. Further, it is estimated that this new type of unit will cost one third less to build for equivalent capacities.

Three Fluid Hydroformers have been licensed by The M. W. Kellogg Company. These include a 20,000-barrel-per-day plant for Cities Service at Lake Charles, La., a 10,000-BPD plant for for Cities Service at East Chicago, Ind., and a 2000-BPD unit for Pan-Am Southern Corporation at Destrehan, La.

A simplified flow diagram for the Fluid Hydroforming process is shown in Figure 5. Fresh feed is charged through heat exchange to a furnace, where its temperature is raised to approximately 950° F. From there the feed is charged under a pressure of approximately 200 psig to the base of the reactor in which the fluid bed is maintained. The vaporized naphtha, after mixing with hydrogen-rich recycle gas, passes up through the bed where the hydroforming reactions are effected. After disengagement of the major portion of the catalyst in the upper portion of the reactor, the effluent vapors pass through cyclones and

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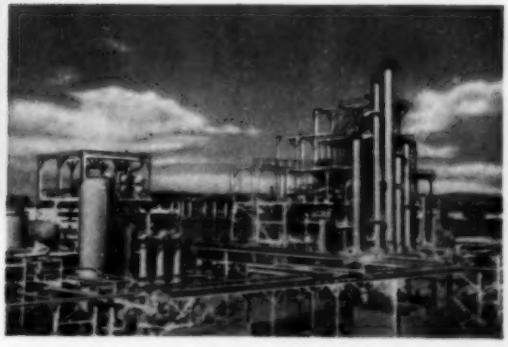

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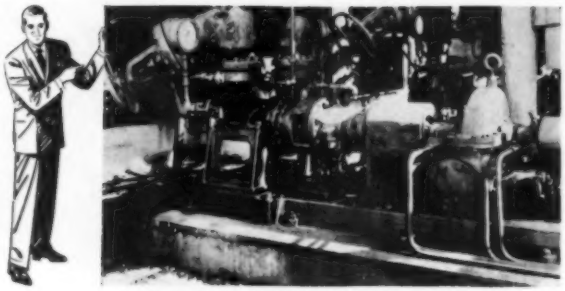

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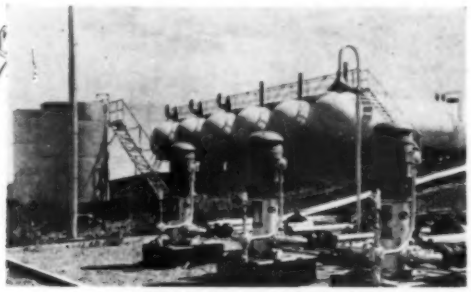
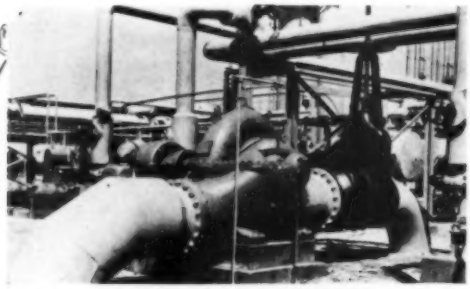


WORTHINGTON QER VERTICAL centrifugal process pump, shown at Magnolia Petroleum Company, Chitwood, Oklahoma, is used to transfer propane, butane and LPG.



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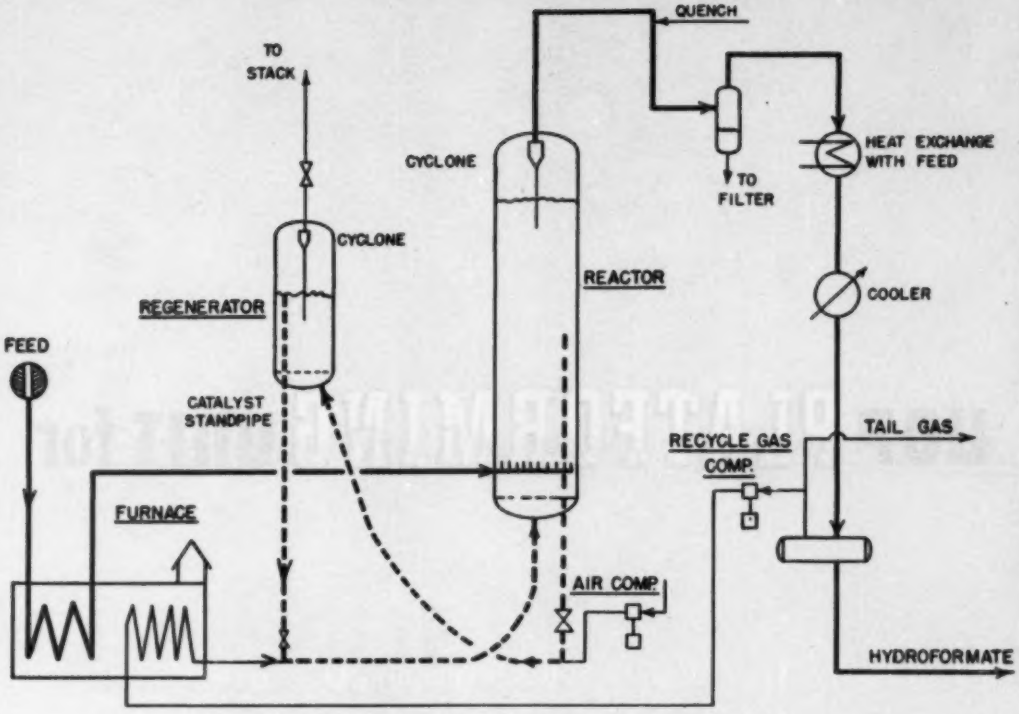

Figure 5. Fluid Hydroformer. (Courtesy, Standard Oil Development Company.)

are scrubbed with a recycle stream in order to remove all entrained catalyst. The vapors are then heat-exchanged against the feed stream, further cooled, and introduced to a high-pressure receiver which separates the hydrogen-rich gases from the gasoline. The gasoline is stabilized and sent to storage, while the gases, after compression, are reheated in a furnace and recharged to the reactor.

The movement of the fluid catalyst is similar to that in Fluid catalytic cracking. From the reactor it passes through a stripper to remove and save hydrocarbon product, and is then charged to the regenerator where the coke is burned off before return to the reactor. One major difference from Fluid cracking is that the Fluid Hydroformer regenerator is much smaller since the amount of carbon deposition is but a fraction of that incurred in cracking.

Typical Fluid Hydroforming results obtained in a 50-barrel-per-day pilot plant are presented in Table 9. The

TABLE 9
Recent Results in 50-Barrel Fluid Hydroforming Pilot Plant
Feed: 200/330° F. Mixed Base Naphtha

Severity	I	II
CFRR Octane No. Clear, 10 lb. RVP Gasoline	90	96
CFRR Octane No. plus 3 ml. TEL	98	101
Yields:		
10 lb. RVP-400° F. E. P. Gasoline, Vol. percent	97.5	90.0
Extraneous Butane to 10 lb. RVP, Vol. percent	8.0	4.5
C_5-400° F. E. P. Gasoline, Vol. percent	86.0	80.0
Butanes, Vol. percent	3.5	5.5
Polymer, Vol. percent	0.2	0.2
Dry Gas, Wt. percent	6.0	10.5
Carbon, Wt. percent	0.6	0.8

charge stock in this case was a 200/330° F. mixed-base naphtha having CFRR octane ratings of 49 clear, and 64 with 2 cc TEL.

These and other pilot plant results indicate that yields will be on the order of three to five percent higher than that of the fixed bed process for equivalent octane improvements. This is attributed largely to the uniform temperature maintained throughout the Fluid bed, an inherent characteristic of the fluidized technique. Reactor pressures are also moderate in comparison with other catalytic reforming processes. As a result, the process shows better liquid recovery. The final gasoline product also contains less butane. This means that the refiner can advantageously blend extraneous butanes from other refinery sources into the hydroformed gasoline in bringing it up to the permissible 10-pound Reid vapor pressure.

* * *

REFERENCES

[1] Egloff, Gustav, Petroleum Refiner, July, 1951, p. 127.
[2] Fulton, W. F., Petroleum Refiner, Dec., 1950, p. 109.
[3] Haensel, Vladimir, Petroleum Refiner, April, 1950, p. 131.
[4] Haensel, Vladimir, "Aromatics by the Platforming Process," Lecture presented before The Chemical Engineers Club, The National Capitol Section of the American Institute of Chemical Engineers, Washington, D. C., April 23, 1951.
[5] Kirkbride, C. G., Petroleum Refiner, June, 1951, p. 95.
[6] Read, Davis, Petroleum Refiner, March, 1951, p. 120.
[7] Wright, Jesse F., Petroleum Refiner, September, 1950, p. 163.
[8] Petroleum Refiner, April, 1950, p. 128.
[9] Petroleum Refiner, March, 1951, p. 88.

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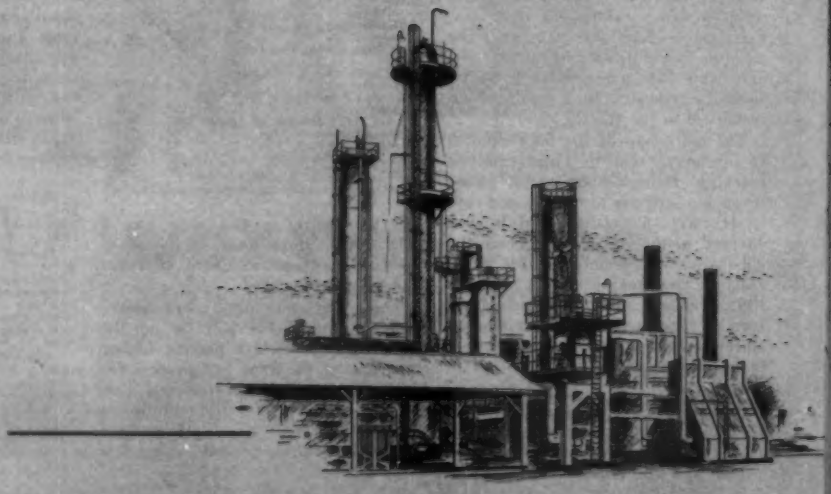

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Modern Trends in Gas Plants For Catalytic Cracking Units

FORREST E. GILMORE and ROBERT D. BAUER

Phillips Petroleum Company, Bartlesville, Okla.

ONE of the opportunities most oil refiners have to increase their profits lies in more efficient recovery and use of the lighter hydrocarbons instead of leaving considerable of them in the refinery fuel gas. More attention could well be given to the design and operation of the refinery gas plant to obtain the most profitable results from the conditions encountered. The olefins recovered, such as butylenes, propylene and possibly even ethylene, are valuable raw products to be further refined by catalytic polymerization, alkylation or other conversion processes to exceptionally high octane gasoline suitable for improvement of motor fuel or as the principal ingredient in aviation gasoline. The alkylation of light olefins requires about 1.2 barrels of isobutane per barrel of olefin consumed. The isobutane obtained from the gas plant is usually insufficient to alkylate all the olefins. If isobutane for this purpose is not otherwise economically available it can usually be obtained by isomerizing part of the n-butane recovered in the gas plant.

While it is not our purpose to discuss the relative merits of catalytic polymerization and alkylation, it is noteworthy that catalytic polymerization utilizes only about 80 percent of the olefins in the light hydrocarbons recovered in the gas plant, while alkylation utilizes all these olefins and 120 percent of the olefin volume of isobutane to produce almost three times as much alkylate as polymer.

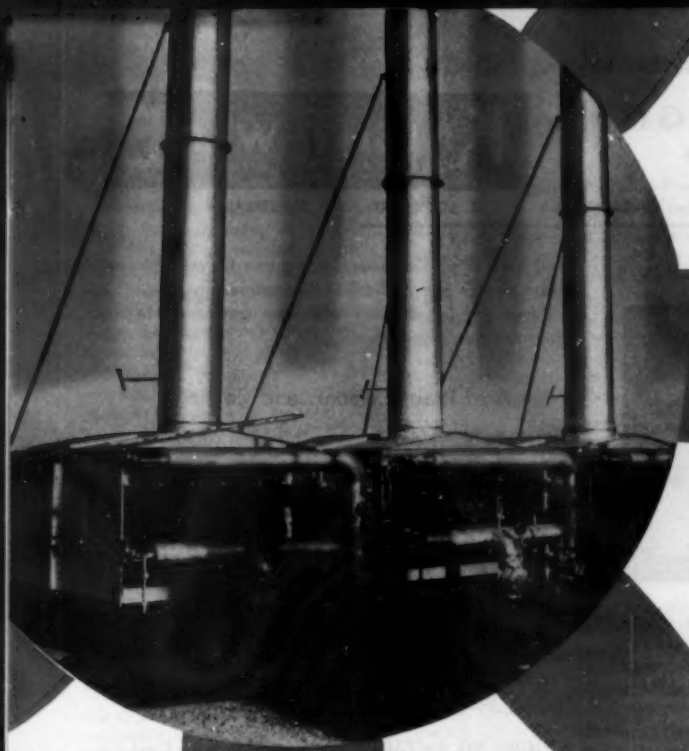
In recovering the light olefins from catalytic cracking unit gases, a slightly greater amount of saturated light hydrocarbons are also recovered. More than one-half of these are usually isobutane which can be used in alkylating the olefins. The remaining normal butane can usually be included in motor fuel. This leaves the propane for use as fuel when other fuel prices are high or for sale as LPG when its price justifies. In the past LPG prices have varied greatly, it being completely unmarketable at times, especially in the summer months. The recent rapidly expanding market for its use as motor fuel, fairly well developed for use in farm tractors and now being developed in buses and fleet motor vehicles, indicates the growth of a more stable and higher priced market.

In the Society of Automotive Engineers symposium of last January in Detroit, the use of LPG as tractor and automobile fuel was discussed in relation to supply, distribution, adaptation and operation. The growth in customer demand is illustrated by the number of LPG conversion units of farm tractors made in the past three years which were 25,300 in 1948; 37,200 in 1949 and it is estimated they exceeded 100,000 in 1950. Buses are now being factory-engineered and produced especially for using LPG with engines having compression ratios as high as 12 to 1. One of the country's largest bus systems placed a single order for 500 new buses of this type. This trend may well put LPG into the high value liquid fuel market rather than remaining in the low value gas and fuel oil market. There is even a possibility that the great increase in the value of LPG as direct motor fuel might greatly decrease its use in catalytic conversion processes. In the future it will probably become more and more economically feasible to more efficiently extract LPG from refinery gases. This will conform to the basic concept of refiners that they must convert their relatively expensive raw product into the final product giving the highest margin of profit which product is usually not fuel for their stills.

Refinery gas extraction plants are usually of two general process types: Compression and oil absorption. Virtually all of the recent plants have been of the absorption type which has great advantages over the compression type when high propane-proylene extraction is desired. Other extraction processes which could be used include adsorption on activated charcoal and direct fractionation of the gas. The adsorption on activated charcoal appears to be suitable only for removing the last traces of propane-propylene from the residue gas of inefficient extraction units. Direct fractionation with refrigerated overhead condenser could in all probability be worked out satisfactorily process-wise and might be competitive with oil absorption for extremely high extraction efficiencies. The oil absorption plant is pretty definitely the most advantageous method of recovering between 70 and 90 percent of the propane-propylene in the gases from a catalytic cracking unit. Oil absorption plants can obtain a high recovery of propane in almost any range of operating temperatures

THE CONTINUED rapid increase in installations of catalytic cracking units which not only increase the yield of light hydrocarbons from crude oil but provide gas streams rich in light olefins suitable as feed to polymerization and alkylation units for conversion into very high octane number gasoline blending stocks has supplied incentives for higher extraction efficiencies in refinery gas plants and for study and comparsion of the various ways by which such higher extractions may be most economically accomplished. Results of computations made to compare the effects of absorption temperatures and pressures, the number of theoretical trays in the absorber, the use of deethanizing absorbers, the uses of sponge oil absorption to prevent losses of lighter absorption oil components to residue gas and the utilization of various refinery streams as absorption oil are presented.

Original presentation was before the Kansas City Regional meeting of the American Institute of Chemical Engineers on May 15, 1951.



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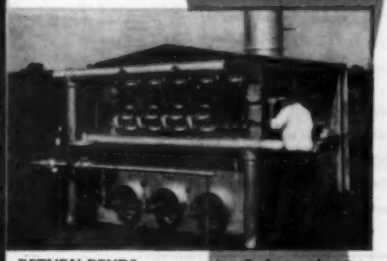

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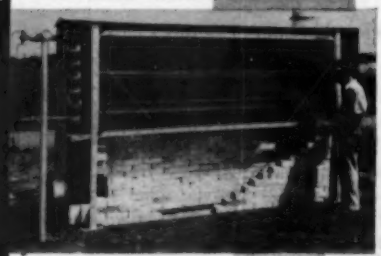

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and pressures. Low temperatures through refrigeration may be used in lieu of higher pressure or absorption oil rate.

The four principal factors contributing to high extraction in an absorber are: Increase in pressure, increase in the molal ratio of absorption oil to gas, lower temperature of absorption and increased number of equilibrium stages i.e. theoretical trays. Another factor in the overall propane recovery efficiency of the gas plant is the absorption of undesirable light fractions such as ethane and methane which must usually be removed from the gas plant products and in the removal carry propane and propylene along with them. These gases can be recirculated through the absorber thereby adding to its gas load and requiring more absorption oil, a higher absorption pressure or lower absorption temperature for the higher extraction necessary to obtain a net over-all propane extraction efficiency which in turn increases the extraction of undesirable light gases until a large and expensive recycle builds up. To avoid this to some extent it is now becoming customary to add a rich oil deethanizing section to the absorber below the feed, the rich oil being treated with a reboiler.

High Propane-Propylene Recovery In Oil Absorption Plants

While there are many variations of the highly complex oil-absorption plants the basic methods of computing the effect of various factors are well established and are briefly outlined in the following. The recovery of hydrocarbons from a gas in an absorber is a function of the absorption factor A defined by the following equation:

$$A = \frac{L}{KV}$$

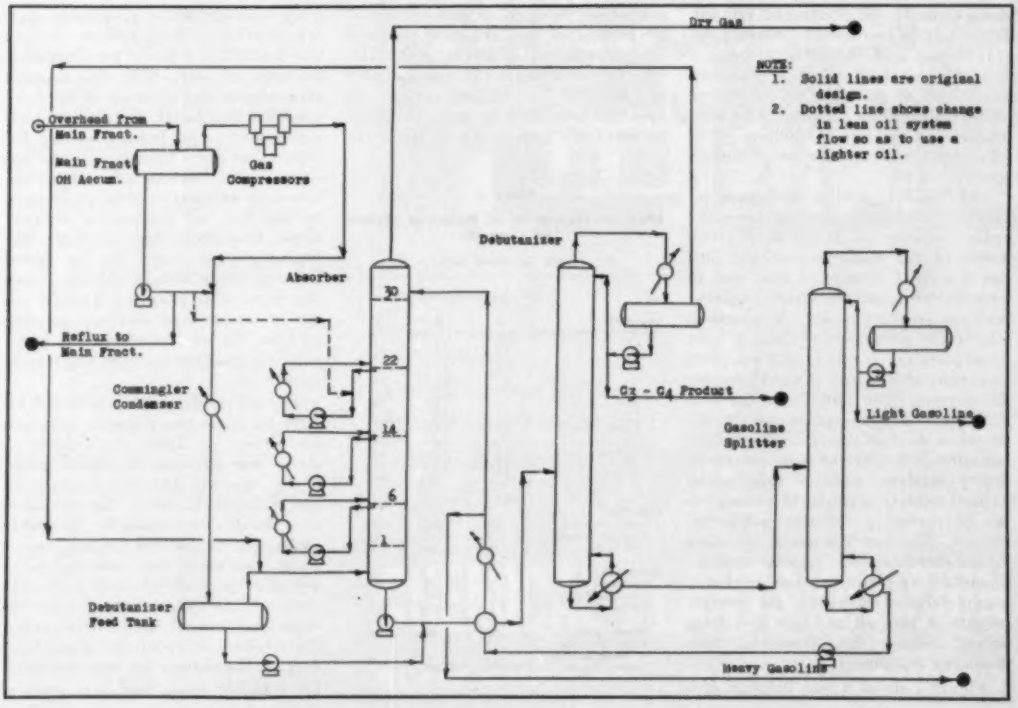
where, A = absorption factor
L = mols per unit time of downflow oil
V = mols per unit time of upflow vapors
K = equilibrium constant of the component under consideration

Increasing the absorption factor, A, at a given set of operating conditions and fixed number of equilibrium steps, increases the absorption of the chosen component. An analysis of the terms in the absorption factor equation leads to the following methods of increasing the extraction of gas components in the absorber: 1) Increase the molal oil rate by increasing the oil volume rate or by using a lighter absorption oil; 2) Decrease the molal vapor rate by decreasing gas feed rate as a result of condensing more of it by means of greater cooling with or without commingling in the condenser with gasoline or by decreasing the recycling to the absorber of ethane and lighter gases previously absorbed; and 3) Decrease the equilibrium constant "K" by absorbing at lower temperatures or higher pressures.

These three methods by which the absorption factor, A, can be increased are now considered in more detail.

In designing a new oil absorption plant the absorption oil rate required for a specified extraction does not present the problems usually encountered in revamping an existing unit for higher propane recovery. In a new plant the absorber and subsequent towers and their auxiliary equipment may be sized to handle the required oil rates while increasing the oil rate in an existing unit to increase propane recovery may entail considerable changes in the mechanical design of existing equipment. If the existing absorber is operating at its liquid han-

Figure 1. Catalytic Cracking Unit Gas Plant for Moderate Propane Recovery.



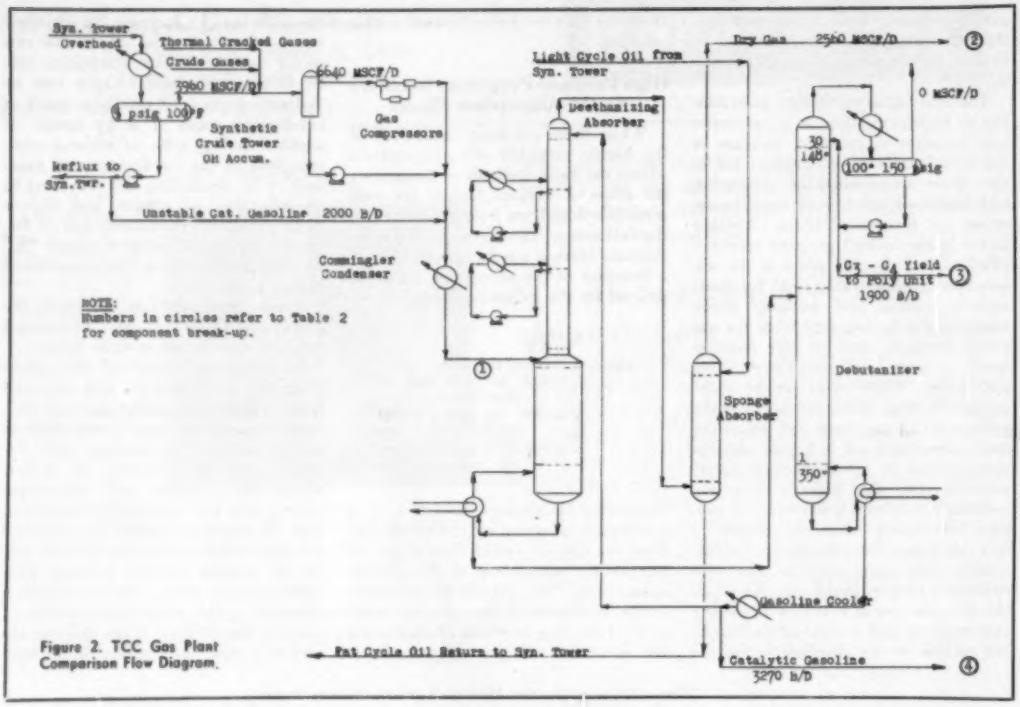


Figure 2. TCC Gas Plant Comparison Flow Diagram.

dling capacity, the effective oil rate can frequently be increased by altering the tray details and downcomers, using a lighter absorption oil thus obtaining more mols of downflow oil per barrel of liquid handling capacity or by both increase in the liquid handling capacity of the trays and the use of lighter absorption oil.

Debutanized gasoline and more recently unstabilized gasoline from the main condenser of the synthetic crude tower of the catalytic cracking unit are principal absorption oils used in recently designed catalytic cracking unit gas recovery plants. As an example of the advantage of using a light absorption oil in a TCC unit gas plant operating at 225 psig it would require 60 percent more barrels of the old-fashioned 200 molecular weight absorption oil than unstabilized catalytic gasoline or 20 percent more barrels of heavy catalytic gasoline than unstabilized catalytic gasoline to accomplish an 85 percent propane-propylene recovery. The big advantage in using unstabilized catalytic gasoline over debutanized catalytic gasoline is that it completely eliminates the recycle stream of lean oil and thus to a large extent unloads the subsequent fractionating equipment.

Figure 1 shows a flow diagram of a gas plant designed to recover about 60 percent of the available propane from a catalytic cracking unit. The lean oil was a heavy catalytic gasoline of 350-430° F. boiling range. It operated satisfactorily at the designed recovery efficiency and a decision was made to increase the propane-propylene recovery to the maximum amount that could be obtained by increasing the lean oil rate. With this original arrangement and capacity of the fractionation equipment the lean oil rate was found to be limited not by the liquid handling capacity of the absorber but by the capacity of the debutanizer reboiler so that an increase in the lean oil circulation of only about 10 percent was obtained. The piping change shown by the dotted line was made without shutting down the unit. This change permitted the use of unstabilized catalytic gasoline as lean oil with a stream of heavy catalytic gasoline over the top tray as sponge oil.

TABLE 1

Effect on Absorption of Molecular Weight of Lean Oil

(From Operating Tests)

Component	Residue Gas Mol. Percent		
	A	B	C
CO	1.0	1.5	1.3
CO_2	1.4	1.7	1.3
N_2	12.4	8.1	7.6
O_2	0.7	0.6	0.5
H_2	48.2	52.4	53.9
H_2S	1.2	1.5	1.3
C_1	17.7	15.4	15.9
$C_2=$	2.5	4.4	3.1
C_2	7.4	6.8	5.4
$C_3=$	3.9	4.1	2.8
C_3	2.9	2.5	1.9
C_4+	0.7	1.0	5.0
	100.0	100.0	100.0
Lean Oil:			
Barrels per Hour	280	225	250
Molecular Weight	155	117	117
°API @ 60°	36.9	54.2	54.2
Sponge Oil:			
Barrels per Hour	0	50	0
Molecular Weight	.....	155	.....
°API @ 60°	.....	36.9	.....
Pressure, psig.	140	140	140
Total Fractionator reboiler, steam required, lbs./hr.	41,800	25,400	.....

Typical residue gas analyses and oil rates for these two types of operation are shown in Table 1. Column A shows the previous operation using heavy catalytic gasoline as lean oil and Column B shows the operation after the change was made. This table shows that the residue gas analyses of these operations are comparable as are also the total oil rates to the absorber. This indicates that, under the same total lean oil rate to the absorber, the recovery is about the same; however, by the change, the total fractionator reboiler steam load was reduced

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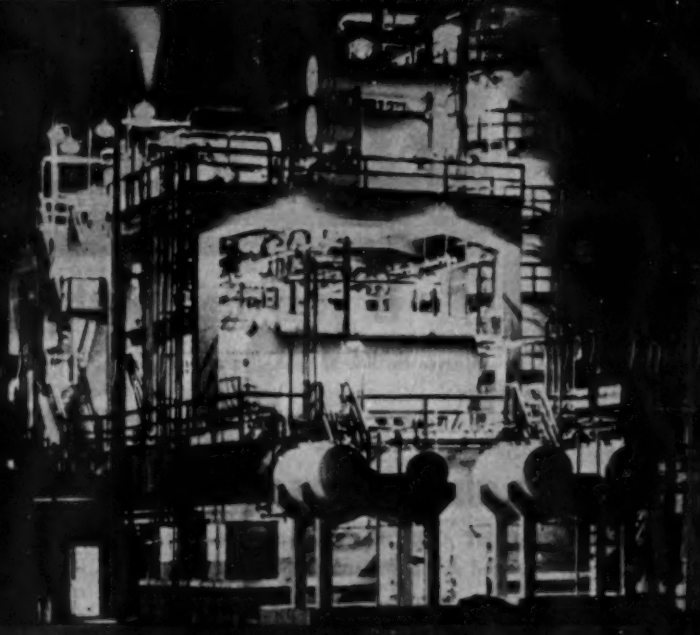

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40 percent. In the change the eight top trays of the absorber were taken over as a sponge oil section with only 50 B/H over its trays. This means that residue gas B was actually obtained with fewer trays than residue gas A thus showing by actual operating data the advantage of using light absorption oil. Calculations made on the changed type of operation with 200 barrels per hour of unstabilized catalytic gasoline as lean oil and 200 barrels per hour of heavy catalytic gasoline as sponge oil showed an increase in propane extraction to about 80 percent and that the load on the subsequent fractionation equipment would be considerably less than it was under the original 60 percent propane recovery operation.

Column C of Table 1 shows why it is important to have an adequate sponge oil section when using light absorption oil. Since the gas leaving the top of the absorber is at its dew point and attains this condition by equilibrium contact with the sponge oil, it is evident that a heavy sponge oil is advantageous since it will not only recover the components stripped out of the light lean oil by the gas but also will allow very little of itself to pass out in the residue gas. Catalytic gas oils, which can readily be obtained from and returned to the main fractionator of the catalytic cracking unit, are excellent sponge oils, however, if they are used it is best to have the sponge oil section as a separate small absorber rather than as the top section of the main absorber in order to eliminate any possibility of contaminating the gasoline yield with the gas oil through a faulty trap-out or leaky tray.

The principal advantages in using light absorption oil, in addition to increased absorption per barrel used, consist of unloading of reboilers and coolers, reduction in pumping costs, and compared with absorption oils heavier than gasoline the elimination of the lean oil still including expensive heat exchangers, heaters, condensers and lean oil coolers.

Gas Feed Rate

Careful consideration should be given to lowering the volume of rich feed to the absorber by operating at the highest pressure consistent with the plant's ability and cooling the rich gas as nearly as practical to cooling water temperature thus condensing as much as possible of it. It is probable that refrigeration of the catalytic cracking unit main condenser gas in commingling relation with the condenser liquid to between 40 and 50° F. is justified because it will not only reduce the gas feed to the absorber but will also greatly decrease the gas volume to the gas compressors as well as increase the volume of unstabilized catalytic gasoline available as absorption oil. Commingling of the compressed gases from a catalytic cracking unit with the unstabilized catalytic gasoline in a condenser will reduce the absorber feed gas volume. However, a more advantageous use of the unstabilized catalytic gasoline is to be had by using it for lean oil.

To those familiar with catalytic cracking, the residue gas compositions shown in Table 1 indicate the unit is suffering from metallic poisoning of the catalyst. Metals in the gas oil feed deposit on the catalyst converting part of it into a dehydrogenation catalyst resulting in the production of hydrogen and coke at the expense of gasoline yield. Thus it is apparent that one very desirable way of decreasing the gas volume charged to the catalytic cracking unit absorber consists in the elimination of this metallic poisoning of the cracking catalyst.

Another way of lowering the gas volume to the absorber, usually by about 5 to 7 percent, is by better stripping of the regenerated catalyst so that the very minimum amount of inert gases are allowed to enter the reactor and pass on into the gas recovery system.

The elimination or lowering of any recycle gases to the absorber will result in more efficient recovery. For this reason it is advisable to operate the fractionation equipment following the absorber at the highest pressure and with the lowest temperature possible on the overhead condenser of the column and thus hold the recycle gas volume at a minimum.

Pressure and Temperature

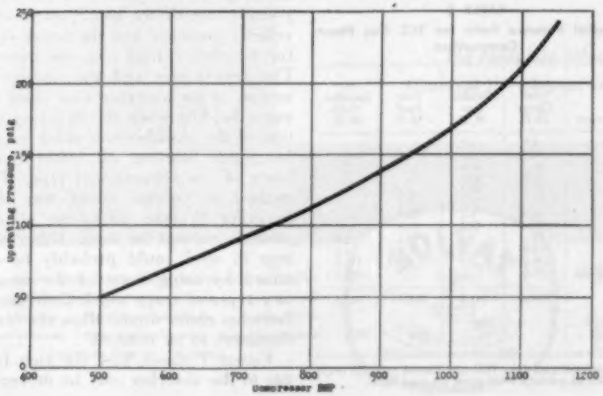
The absorption formula shows that the absorption factor of each component of the gas varies inversely as the equilibrium constant and since increased pressure or decreased temperature decreases the equilibrium constant they will also increase the extraction efficiency of the absorber. However, the equilibrium constants of the various components of the gas are not equally affected by changes in pressures and temperatures, those of the heavier hydrocarbons being affected relatively more by temperature changes and those of the lighter hydrocarbons being affected relatively more by changes in pressure. This means that a lowering of the absorption temperature would favor butane absorption while having little effect on ethane absorption and going to high pressures so greatly favors methane and ethane absorption that the elimination of these undesirable gases from the final products may become a serious problem.

In order to show the effect of various customary absorption pressures, process designs were made of gas plants to process the combined gases from a TCC unit, a thermal cracking unit and a crude unit at absorption pressures of 60, 150 and 225 psig. The following premises were used for each of these calculations:

1) Recover 85 percent of the available propane-propylene, and

2) Use an absorber with a fractionating section below the gas feed entrance to deethanize the rich oil, sufficiently that the LPG propane from the depropanizer of a catalytic polymerization unit, utilizing the debu-

Figure 3. Pressure Vs. Compressor BHP.



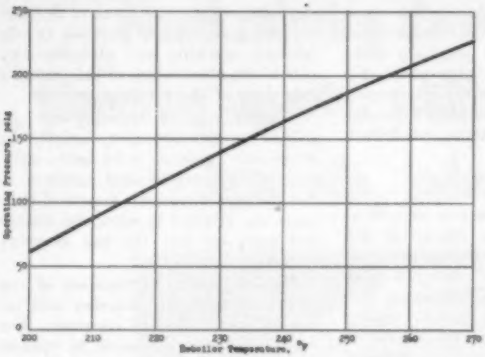


Figure 4. Pressure Vs. Reboiler Temperature in TCC Deethanizing Absorber.

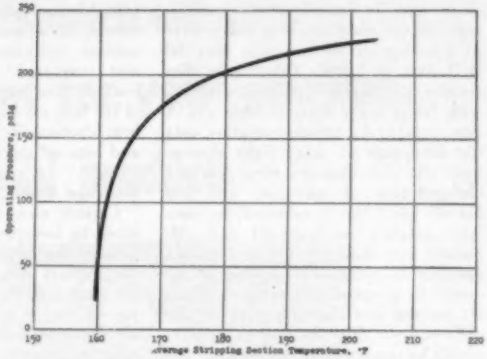


Figure 5. Pressure Vs. Stripping Temperature in TCC Deethanizing Absorber.

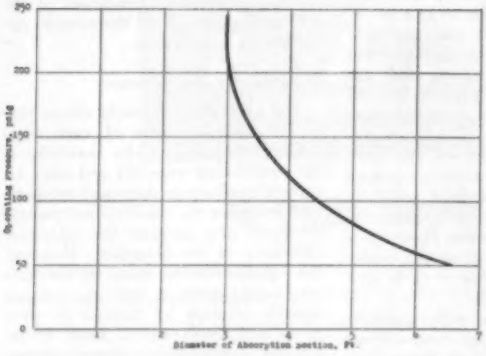


Figure 6. Pressure Vs. Absorption Section Diameter in TCC Deethanizing Absorber.

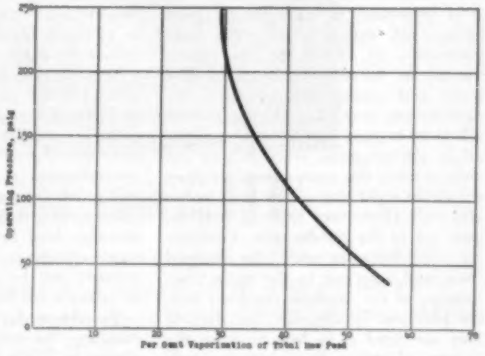


Figure 7. Pressure Vs. Condensation of Raw Feed Gas in TCC Unit.

tanizer overhead liquid stream, would need no further deethanization.

The over-all material balance for each gas plant design is the same, regardless of the operating pressure, and is shown on a molal basis in Table 2. Figure 2 shows the process flow used for the plants and Table 3 the results of the calculations and the design data. It will be noted from these data that as the operating pressure is increased the differences between the plants begin to narrow. For example, differences in oil rates, heat duties, operating expenses, etc. are much greater between the 60 and 150 psig cases than they are between the 150 and 225 psig cases. There appears to be little difference between the 150 and 225 psig cases from the standpoint of equipment requirements for the absorber and debutanizer. One notable exception to this is the compressor brake horsepower requirement, which continues to increase fairly rapidly as the pressure is increased. The absorber reboiler temperature and the average stripping section temperature also increase with the operating pressure. These trends are shown graphically on Figures 3, 4 and 5. In Figure 6, the required diameter of the absorption section is shown as a function of the operating pressure and indicates

TABLE 2
Material Balance Data for TCC Gas Plant Comparison

Component	(1) Total[1] Charge M/H	(2) Residue Gas M/H	(3) Poly Feed M/H	(4) Gasoline Yield M/H
Inerts	4.2	4.2	....	....
H_2S	6.1	5.5	0.6	....
H_2	91.7	91.7	....	....
C_1	82.9	82.9	....	....
C_2	59.6	56.7	2.9	....
$C_2^=$	18.6	18.4	0.2	....
C_3	84.2	8.2	76.0	....
$C_3^=$	75.0	13.2	61.8	....
C_4	92.1	....	90.1	2.0
$C_4^=$	72.9	....	71.4	1.5
C_5	119.6	....	3.1	116.5
C5-350° EP	227.5	....	....	227.5
	934.4	280.8	306.1	347.5
MSCF/D	....	2560	....	....
Bbls/SD	....	....	1900	3370

[1] Combined gases from TCC unit, thermal unit, and crude unit plus all synthetic crude tower overhead liquid.

that, under the conditions chosen for this problem, increasing the pressure decreases the diameter but at a diminishing rate.

In determining the size of the columns for this comparison, the liquid and vapor loading were calculated, the latter at 100 percent of the value given by the Brown and Souders mass velocity equation and the tower sized for whichever load was the greater. The debutanizer and the absorption section of the absorber were sized for vapor loading while the stripping section of the absorber was sized largely for liquid loading, all bubble trays being of the conventional type. This method of column sizing was used in order to take advantage of any possible savings in steel. Other savings in steel could probably be obtained by using some of the special new types of trays which their manufacturers claim would allow the tower diameters to be reduced.

Figure 7 shows how the rich feed gas to the absorber may be decreased

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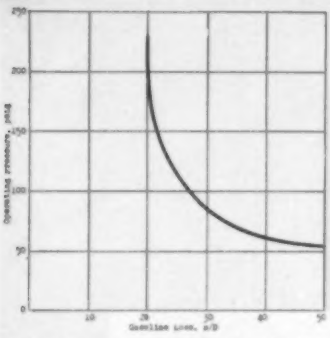

Figure 8. Pressure Vs. Gasoline Loss to Dry Gas from TCC Deethanizing Absorber.

by compressing it to a higher pressure, and commingling it with the unstabilized catalytic gasoline while cooling to 100° F. This, however, is an expensive method of decreasing the gas volume to the absorber because in going from 150 to 225 psig the compressor horsepower is increased by 20 percent while the gas volume decreases 15 percent.

Figure 8 shows the loss of gasoline to the residue gas as a function of the operating pressure and indicates that operating at 150 psig as compared with 60 psig will save about $80 per day in gasoline losses. There is little difference between the gasoline lost by operating at 150 and 225 psig.

Figure 9 shows the lean oil required to obtain the 85 percent propane-propylene extraction as a function of the total gas feed to the absorber and the operating pressure. This curve indicates that at pressures above 200 psig the lean oil requirement per MSCF of feed gas begins to level out. This behavior is also evident from the fact that the equilibrium constants of propane and heavier are increasingly sensitive to temperature changes as the temperature decreases below 150° F. and decreasingly sensitive to pressure changes as the pressure increases, especially for pressures above 200 psig.

Figure 10 shows the gas loads at various points in the deethanizing absorber. This figure shows that while operation at the higher pressure may decrease the feed gas to the absorber, it will make the stripping operation for deethanization more difficult consequently increasing the internal recycle vapors from the stripping section to almost the same extent the feed gas is decreased.

Based on the above, it appears that the 60-psig case when using temperatures obtained by the use of cooling tower water, cannot be economically employed to the best advantage thus narrowing the choice down to the 150 and 225-psig cases, neither one of which has any decided advantage over the other. The 150-psig case appears to be nearer the optimum point on the curves and should cost somewhat less to construct and operate.

Table 4 shows a comparison between the previously described 150-psig plant and a 150-psig plant using butane refrigeration for cooling the lean oil and the absorber intercoolers to obtain an average absorption temperature of 50° F. The material balance is the same as for previous cases. The greatest saving by using refrigeration is in the lean oil circulation which was reduced to about 70 percent of that required in the plant without refrigeration. Additional savings were obtained in reboiling steam and cooling water costs while gasoline losses to residue were reduced to practically none. The 265 brake horsepower required for the refrigeration is a cost which is partially offset by savings in sizes of reboilers, condensers, coolers and pumps. It seems that this application of refrigeration is justified by the savings in operating costs and reduction of gasoline losses to the residue gas. While no detailed comparisons have yet been made, it may well be that the optimum pressure for 50° F. absorption is much lower than the 150 psig used. Also, that applying refrigeration to the main fractionator overhead condenser of the catalytic cracking unit thus greatly reducing the gas to the compressor and to the absorber and in turn supplying more unstabilized catalytic gasoline for lean oil so that no debutanized gasoline need be recycled for lean oil would prove to be a more economical type of gas recovery plant.

TABLE 3
TCC Gas Plant Comparison at Various Operating Pressures

Operating Pres., psig.	60	150	225
Propylene-propane recovery	85	85	85
Gas to compressors, MSCF/D	6,640	6,640	6,640
Compressor BHP requirement	550	940	1,125
Commingler condenser duty, M Btu/hr.	4,120	5,350	6,000
Deethanizing Absorber Data			
Top section diameter	6'-0"	3'-6"	3'-0"
Bottom section diameter	7'-0"	5'-0"	5'-0"
Rich gas feed, MSCF/D	4,340	3,330	2,540
Lean gas, MSCF/D	2,560	2,560	2,560
Gasoline lost to lean gas, B/D	83	23	20
Lean oil, B/D	12,910	3,700	3,380
Light cycle oil to sponge absorber, B/D	1,680	820	720
Gallons of lean oil/MSCF of total gas	87	31	25
Rich oil bottoms, B/D	18,080	8,870	8,550
Theoretical absorption trays	10	10	10
Average absorption temperature, °F	100	100	100
Theoretical stripping trays	10	10	10
Average stripping temperature, °F	160	165	200
Reboiler temperature, °F	200	235	270
Intercooler duty, M Btu/hr.	3,200	1,780	1,900
Reboiler duty, M Btu/hr.	11,930	9,400	10,300
Percent vaporization of total feed	50	35	30
Debutanizer Data			
Tower diameter	7'-0"	5'-0"	5'-0"
Feed, B/D	18,080	8,870	8,550
Overhead—liquid, B/D	1,900	1,900	1,900
—vapor, MSCF/D	0	0	0
Bottom yield, B/D	3,270	3,270	3,270
Bottoms lean oil recycle, B/D	12,910	3,700	3,380
Overhead condenser duty, M Btu/hr.	8,900	8,900	8,900
Reboiler duty, M Btu/hr.	22,870	12,300	10,400
Utilities			
Steam—75 psig., lbs./hr.	.....	9,900	11,800
—250 psig., lbs./hr.	27,900	15,000	12,700
Electric power, KWH	118	19	30
Cooling requirements, M Btu/hr.	29,100	26,800	26,900
Estimated operating cost,[1] $/D	374	321	332

[1] Does not include labor.

Deethanizing Absorbers

In any efficient absorption type gas recovery plant the removal of ethane and lighter absorbed components without loss of propane and propylene is a major problem. In plants operating with high propane recovery and without deethanization of the rich oil, vapors from the subsequent fractionators must be reprocessed in either a reabsorber or returned to the main absorber in order to maintain the high recovery of propane. By proper operation of a rich oil deethanization scheme it is possible to operate the fractionators, such as depropanizers or debutanizers, with total condensation of their overhead products at ordinary plant temperatures and pressures and in this way eliminate costly and uneconomical flashing, recycling, recompression and reabsorption operations.

In a recent article[2] the estimated cost of a gas plant using a novel rich oil stabilization scheme was quoted to be 15 percent less than the most economical design that could be otherwise arrived at. Generally, in catalytic cracking unit gas plants it is not necessary to yield an LPG stream as overhead from the depropanizer or debutanizer since the total overhead product from these fractionators is normally fed to some catalytic conversion process. However, if the feed stream to the conversion process is not deethanized it will be necessary to deethanize the propane effluent from such conversion process if it is to be used as LPG. If the conversion process is an HF alkylation unit it will be imperative to have an almost completely deethanized feed for it. The elimination of ethane and lighter is also desirable in order to lower the pressure

requirements on storage vessels and process equipment. The fractionating absorber has proven satisfactory for use in conjunction with catalytic polymerization and LPG production without subsequent deethanization of the propane. Another advantage of the deethanizing absorber is in the rejection of a large percentage of the hydrogen sulfide that would otherwise be recovered with high propane recovery operation. Thus not only can a high recovery of propane and propylene with very little ethane contamination be obtained but also the corrosion troubles in the downstream process equipment and the cost of treatment of the C_3-C_4 stream can be greatly lowered by the use of a deethanizing absorber.

The fractionating absorber has been defined[1] as a fractionating column in which reflux is generated by means of an absorption medium. In any such separation process it is necessary to have a stream of recycle or reflux material present in order to obtain the desired separation. In a fractionating absorber this reflux is supplied by the hydrocarbons dissolving in the absorption oil. A reflux of this type can be increased only by an increase in either the lean oil circulation rate or by the overall effect of those factors, such as temperature and pressure, governing the amount of absorption obtained.

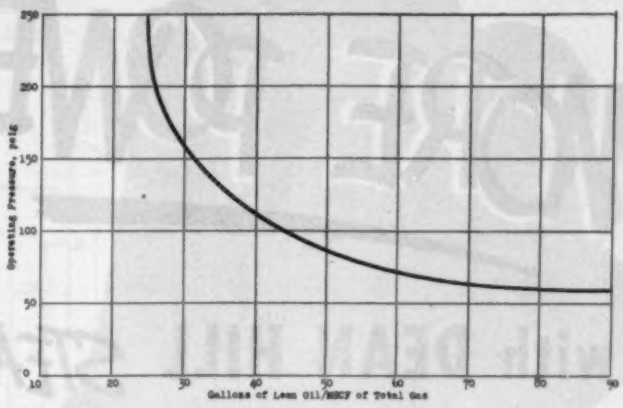

Figure 9 (above). Pressure Vs. Lean Oil Rate in TCC Deethanizing Absorber.

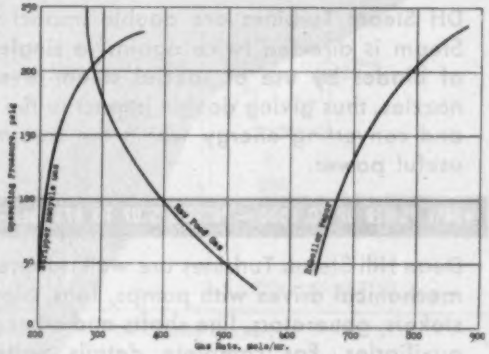

Figure 10. Pressure Vs. Vapor Rates in TCC Deethanizing Absorber.

TABLE 4
TCC Gas Plant Comparison
150 PSIG—With and Without Refrigeration

	No Refrigeration	With Refrigeration[2]
Propane-propylene recovery	85	85
Operating pressure, psig	150	150
Gas to compressors, MSCF/D	6,640	6,640
Refrigeration compressor, BHP		267
Gas compressor BHP requirement	940	940
Total compressor BHP	940	1,207
Commingler condenser duty, M Btu/hr.	5,550	5,550
Deethanizing Absorber Data		
Top section diameter	3'-6"	3'-6"
Bottom section diameter	5'-0"	5'-0"
Rich gas feed, MSCF/D	3,330	3,330
Lean gas, MSCF/D	2,580	2,500
Gasoline lost to lean gas, B/D	23	Negl.
Lean oil, B/D	3,700	2,540
Light cycle oil to sponge absorber, B/D	820	820
Gallons lean oil/MSCF of total gas	31	21
Rich oil bottoms, B/D	6,870	7,710
Theoretical absorption trays	10	10
Average absorption temp., °F	100	80
Theoretical stripping trays	10	10
Average stripping temp., °F	165	165
Reboiler temperature, °F	235	235
Intercooler duty, M Btu/hr.	1,780	910
Reboiler duty, M Btu/hr.	9,400	8,000
Percent vaporization of total feed	35	35
Debutanizer Data		
Tower diameter	5'-0"	5'-0"
Feed, B/D	6,870	7,710
Overhead—liquid, B/D	1,900	1,900
—vapor, MSCF/D	0	0
Bottom yield, B/D	3,270	3,270
Bottoms lean oil recycle, B/D	3,700	2,540
Overhead condenser duty, M Btu/hr.	8,900	8,900
Reboiler duty, M Btu/hr.	12,300	11,300
Utilities		
Steam— 75 psig., lbs./hr.	9,900	
—250 psig., lbs./hr.	15,000	
—340 psig., lbs./hr.		30,900
Electric power, KWH	19	15
Cooling requirements, M Btu/hr.	26,800	21,300
Estimated operating cost,[3] $/D	321	250

[1] Does not include labor.
[2] Applied to lean oil and intercoolers only.

Figure 11 shows a catalytic cracking gas plant that utilizes an extremely efficient fractionating absorber in its scheme of operation. This plant uses a partially stabilized straight run gasoline for lean oil and a heavy gasoline for sponge oil. Table 5 shows an actual material balance for the deethanizing absorber of this plant obtained by a test run when operating at a propane-propylene recovery of 97.8 percent. Even at this extraordinarily high propane-propylene recovery it was possible to totally condense all of the depropanizer overhead vapor and thus eliminate this recycle gas stream. The ethane-ethylene content of the depropanizer overhead liquid was about 3.0 mol percent which is suitable for catalytic polymerization feed stock but would require additional deethanization for use as LPG or alkylation unit feed. However, there is no reason why this deethanizing absorber cannot be made to work a little harder and thus produce LPG as the overhead liquid from the depropanizer.

Since the deethanization operation of the fractionating absorber is the most important factor in its use, it is well to take a brief look into the factors governing the extent of this deethanization. The main or controlling factor is the previously mentioned reflux or recycle material which makes the separation possible. In the deethanization step this reflux material is furnished by the reboiler and stripping section vapors. Figure 12 shows the vapors rising from the stripping section trays at two different propane recoveries. These curves were calculated from the data of two test runs at the conditions and recoveries shown. Both of these curves follow the same general trend and indicate that equal molal boil-up is rapidly approached above the first four or five trays above the reboiler. These two curves also show by their relative positions that a considerable increase in the stripping vapors is required to lower the mol percent of ethane in the rich oil bottoms from 2.4 to 1.4 percent for the conditions shown. These curves also show that as the propane recovery is increased the temperature required to

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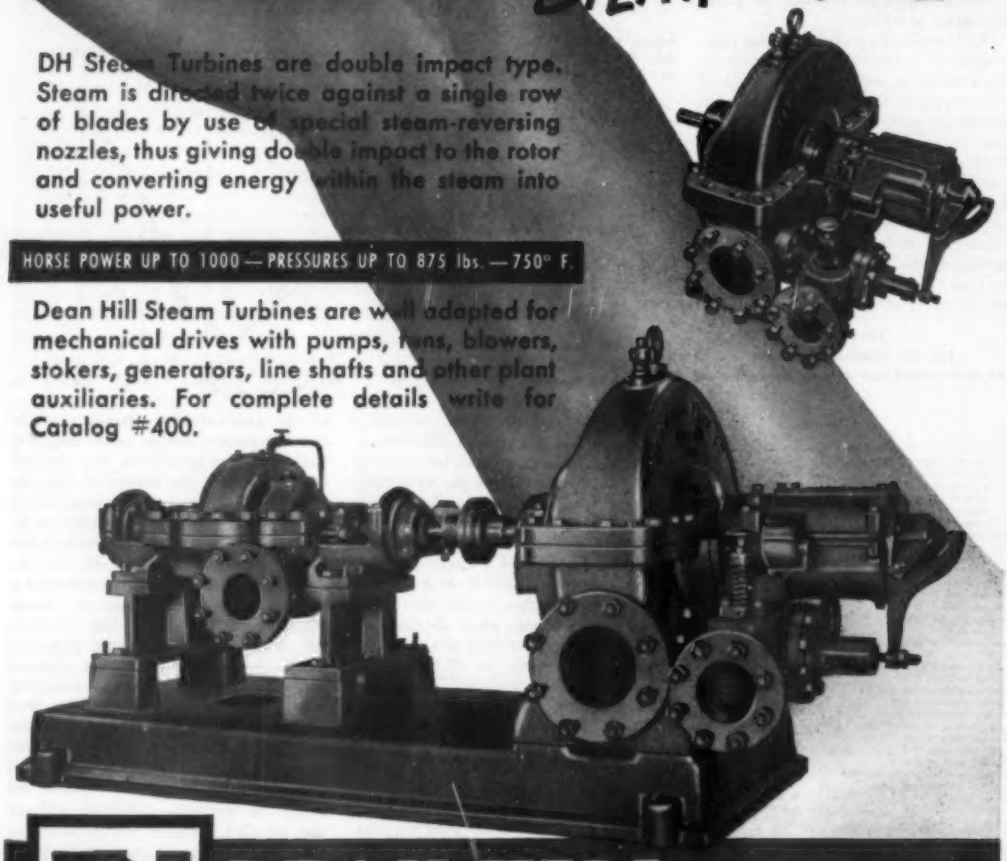

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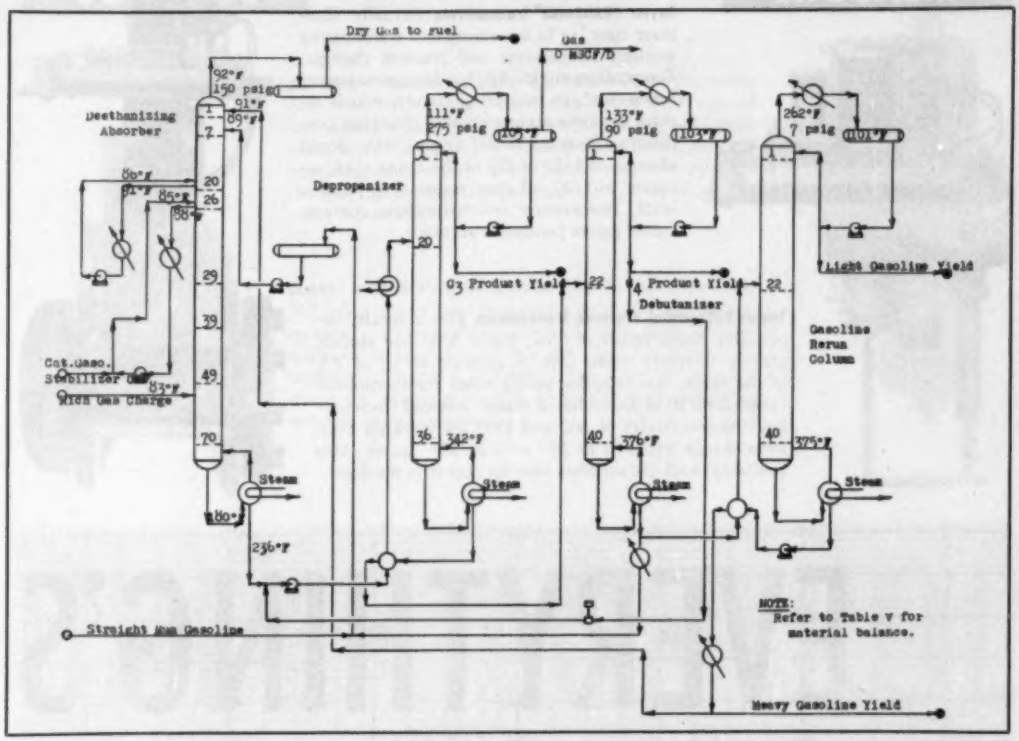


Figure 11. Catalytic Cracking Unit Gas Plant With a Deethanizing Absorber.

do the stripping is slightly decreased. This may be explained by the probability that at the higher recovery figure, more propane is made available to supply the necessary refluxing, or recycling operation, while at the lower propane recovery figure, these recycle vapors will probably have to contain a relatively high percentage of butane.

Figure 13 is a plot of the actual temperature gradient of the stripping section in the deethanizing absorber shown in Figure 11 and during the test run for the material balance shown in Table 5. It is evident from an inspection of the temperature gradient that the bottom 5 to 10 trays were doing most of the deethanization while the remaining trays were serving mostly as a heat exchange section[2] and preventing the stripping heat from

TABLE 5

Molal Material Balance for Deethanizing Absorber

Component	Stabilizer Off Liquid M/H	Rich Gas M/H	Lean Oil M/H	Sponge Oil M/H	Rich Oil Bottoms M/H	Dry Gas to Fuel M/H	Component Recovery[1] Mol. Percent
CO	....	4.4	....	....	....	4.4	0
H_2	....	69.5	....	....	....	69.5	0
N_2	....	25.1	....	....	....	25.1	0
H_2S	....	4.3	....	....	2.3	2.0	53.5
CO_2	....	12.0	....	....	....	12.0	0
C_1	....	131.4	....	....	....	131.4	0
C_2=	7.1	25.9	....	....	1.5	31.5	4.6
C_2	14.1	80.5	....	....	5.5	89.1	8.5
C_3=	72.9	62.8	....	....	132.6	3.1	97.8
C_3	24.1	29.2	8.4	....	60.3	1.4	97.8
C_4=	78.6	30.2	....	....	104.3	1.5	98.6
iC_4	53.0	21.1	9.4	....	81.7	1.8	98.0
nC_4	9.6	5.0	14.1	....	28.2	0.5	90.0
C_5	62.6	22.8	29.9	....	115.5	....	100
C_6+	....	....	932.5	151.0	1083.5	....	100
Total	319.2	494.2	994.3	151.0	1615.4	343.3	....
B/H	89	....	392	69	564	....	....
MSCF/D	....	4,480	....	....	....	3,120	....
Absorption Oil Data:							
°API			50.2	43.1			
Initial boiling point, °F.			136	320			
10 percent point, °F.			302	332			
50 percent point, °F.			390	346			
90 percent point, °F.			368	382			
End point, °F.			426	432			
Estimated molecular weight			124	140			

[1] Based on rich oil and dry gas.

TABLE 6

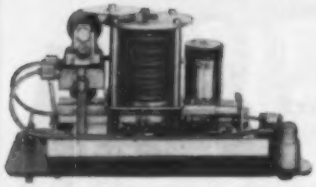
Component Analysis* at Various Trays† in Deethanizer-Absorber Operating at 150 Psig

Component	Tray 65		Tray 59	Tray 26	Tray 20
	Liquid Mol. %	Vapor Mol. %	Vapor Mol. %	Liquid Mol. %	Liquid Mol. %
C_1	....	....	0.3	0.8	1.3
C_2=	9.4	31.9	6.2	0.9	2.0
C_2			53.8	5.9	7.2
C_3=	15.2	27.4	22.1	8.1	3.1
C_3	5.9	9.3	6.2	3.4	1.2
C_4=	4.2	2.8			
iC_4	8.0	6.2	10.5	13.4	2.5
nC_4	3.0	1.8			
C_5	1.5	0.4	0.9	1.9	2.0
C_6+	52.8	0.2	....	65.6	80.7
	100.0	100.0	100.0	100.0	100.0
Tray temp., °F.	122		....	88	91

* Hydrocarbon only.

† Tower containing 70 trays, numbered from the top.

MEASURE



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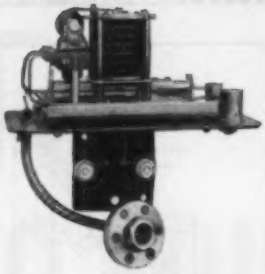

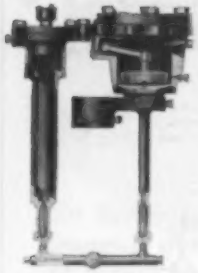

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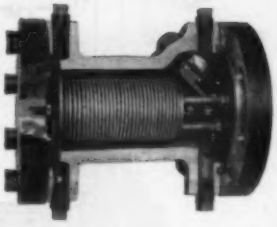

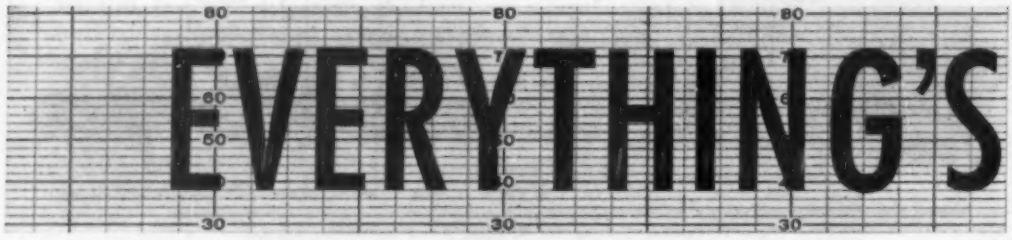

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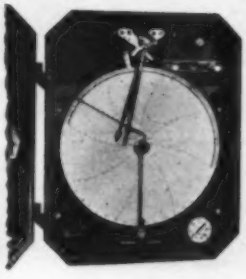
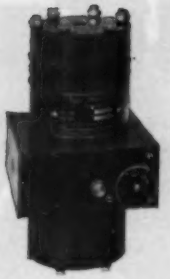


CONTROL



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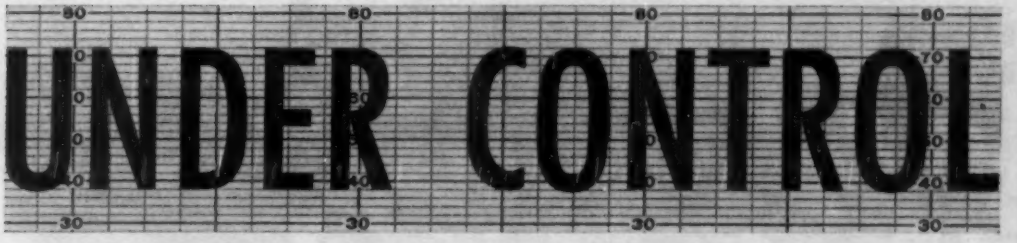

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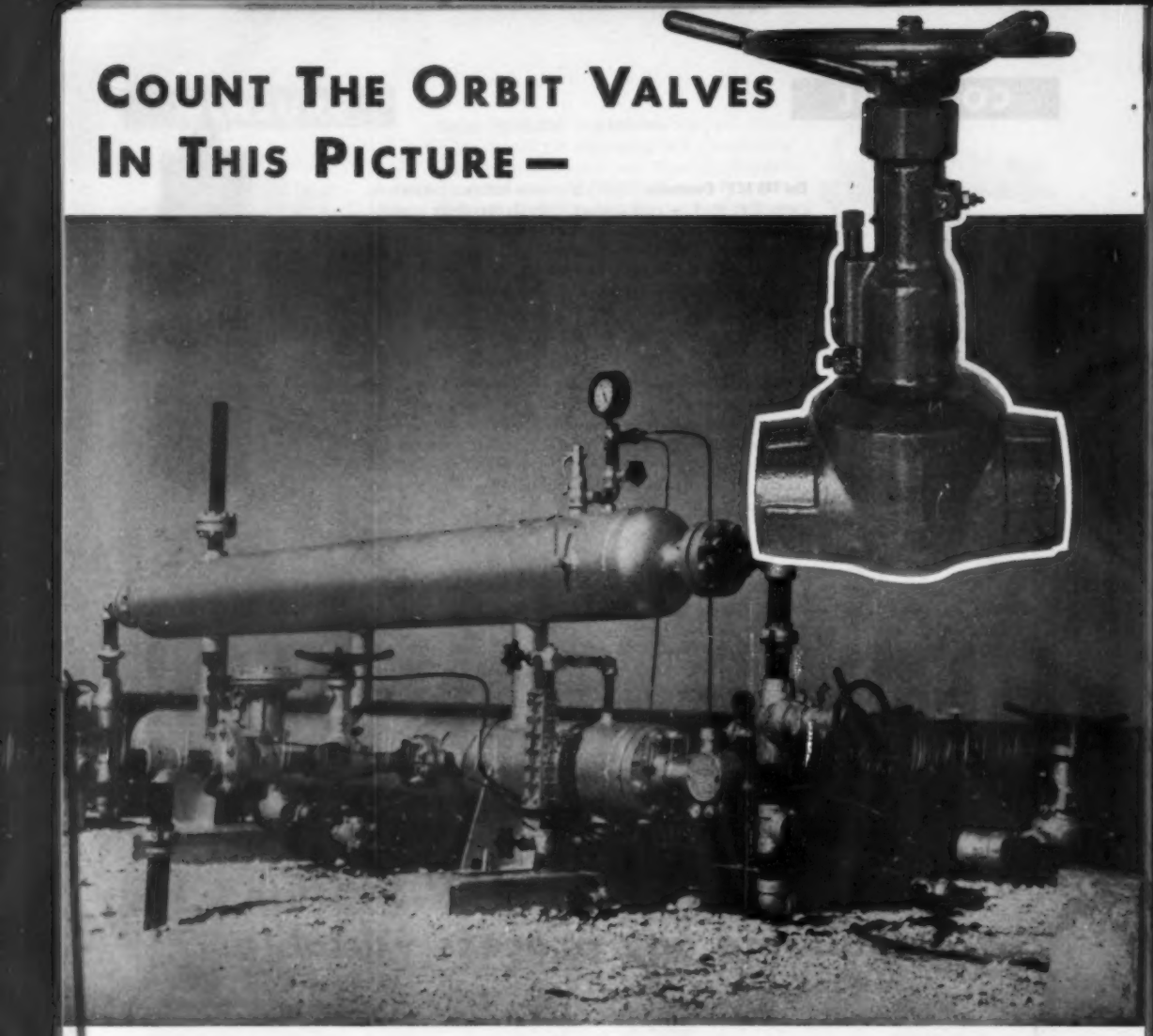

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passing into the absorption section. This behavior is in agreement with the data of Goldblatt and Nelly[2] in that the operation of the absorption section is apparently independent of stripping section temperatures.

Theoretical tray calculations, based on the actual operation of the deethanizing absorber outlined in Figure 11, show an average apparent tray efficiency for the bottom five actual stripping trays of about 80 percent. These agree with the temperature gradient shown in Figure 13 and the data of Figure 12 in that the bottom 5 to 10 trays in the stripping section accomplish practically all the deethanization.

Table 6 shows stream analysis data at various points in the deethanizing absorber when operating at the conditions shown in Table 5. These data, while not conclusive enough to present any concentration gradients for the various components throughout the deethanizing absorber, do stimulate some speculations regarding possible future use of fractionating absorbers, such as the withdrawing of a vapor or liquid sidestream from some point of the deethanization section. A fairly concentrated ethane-ethylene or propane-propylene stream could be obtained in this manner for feed to a catalytic conversion process and in this way eliminate several processing steps which might otherwise be required. Also by withdrawing such a vapor sidestream the absorber could be partially unloaded of its vapor load thus increasing propane extraction.

The operating expenses of a deethanizing absorber may seem somewhat high at first glance because the lean oil rate may be 50 to 60 percent greater than to a straight absorber for the same propane recovery. A comparison between a deethanizing absorber and a straight absorber, without a gas recycle stream is shown in Table 7. In this comparison, about 58 percent more lean oil is required for the deetharizing absorber to obtain the same initial propane recovery as in the straight absorber. However, the high oil rate required for the deethanizing absorber does not appear so excessive when compared with the extra cost of using a reabsorber or a high pressure deethanizer with a straight absorber in order to maintain the initial high propane recovery and yield a propane stream of comparable quality. Also, the necessary recycling of the high pressure deethanizer overhead gases to the straight absorber will require an increased oil circulation to maintain the same high propane extraction. The lean oil to a deethanizing absorber may be said to function not only as the primary lean oil but also as the lean oil for the reabsorber and as reflux for a partial deethanizer. Consequently, the deethanizing absorber may combine the functions of three towers into one tower and at a total oil circulation rate that is no greater than the combined oil and reflux rates for these separate towers.

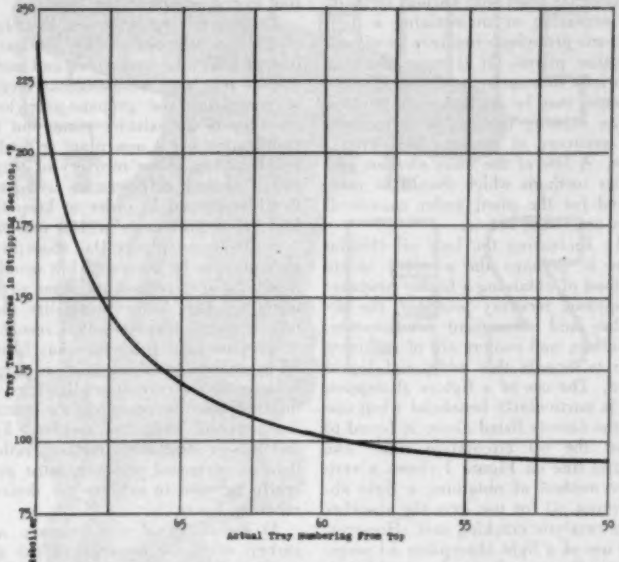

Figure 13. Actual Temperature Gradient of Stripping Section in a Deethanizing Absorber Operating at 150 psig.

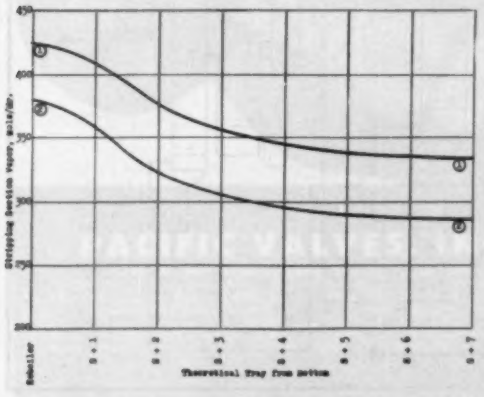

Figure 12. Vapor Boil-Up Rates in Deethanizing Absorber. (Curve No. 1: Gals. total oil/MSCF of rich gas—58; Propane recovery—93.3 mol %; Ethane in rich oil—1.4 mol %; Av. stripping temp., °F.—135; Pressure, psig—150. Curve No. 2: Gals. total oil/MSCF of rich gas—32; Propane recovery—58.8 mol %; Ethane in rich oil—2.4 mol %; Av. stripping temp., °F.—140; Pressure, psig—130.)

Revamping Existing Gas Plants to a High Propane Recovery

For the most part the previous dis-

TABLE 7

Absorber Comparison Data at 130 PSIG Operating Pressure

	Straight Absorber[1]	Fractionating Absorber[2]
Net propane recovery	90.0	90.0
Theoretical absorption trays	10	10
Average absorption temp., °F.	110	110
Rich gas feed, mols/hr.	1350	1350
Lean gas to fuel, mols/hr.	636	723
Gas shrinkage, mols/hr.	714	627
Rich oil rate, mols/hr.	1681	2150[3]
Lean oil rate, mols/hr.	967	1523
Net absorption, mols/hr.	714	627
Propane in lean gas, mol percent	8.3	4.7
Ethane and lighter in rich oil, mol. percent	4.7	0.3[3]

[1] No recycle gas to absorber—i.e. same raw feed as fractionating absorber.
[2] For production of LPG.
[3] Kettle product.

cussion has dealt with various methods of increasing or maintaining a high propane-propylene recovery in oil absorption plants. It is now advisable to briefly summarize how some of these schemes may be applied to the revamp of an existing unit so as to increase the recovery of propane and propylene. A few of the more obvious and easier methods which should be compared for the plant under consideration are listed below:

1) Increasing the lean oil circulation is perhaps the easiest single method of obtaining a higher propane-propylene recovery *provided*, the absorber and subsequent fractionators, reboilers, and coolers are of sufficient size to handle this additional liquid load. The use of a lighter absorption oil is particularly beneficial when one of the factors listed above is found to limit the oil circulation rate. The dotted line on Figure 1 shows a very easy method of obtaining a light absorption oil for use over the absorber in a catalytic cracking unit. However, the use of a light absorption oil necessitates the use of an adequate sponge oil section to eliminate the loss of gasoline hydrocarbons to the lean gas.

2) Maintaining a lower average absorption temperature by refrigeration of lean oils, feed gases, and intercoolers is a very advantageous means of increasing the propane-propylene recovery in an existing plant, but its justification for a new plant is doubtful. However, if the recovery of ethylene is desired, refrigeration will have to be employed in order to keep the lean oil requirements within reason.

3) In some plants the absorption pressure can be increased but usually it will have to remain the same or be lowered. This latter possibility may be one reason why the initial recovery of propane and propylene has fallen off in catalytic cracking unit gas plants because as the corrosion allowance of the equipment becomes less the operating pressure must be lowered. For this reason some other method, rather than an increased pressure, must generally be used to achieve the desired recovery figure.

4) Reboiling of the primary absorber, when the capacity of the absorber will permit it, and converting the bottom 5-10 trays of the absorber into a deethanizing section may prove to be advantageous. These alterations to the primary absorber will make it possible to eliminate the gas stream that must be recycled either to the primary absorber or reabsorber, or disposed of as fuel gas and thus lower a possible source of propane-propylene losses.

5) If the existing absorber does not have sufficient liquid capacity to handle the increased lean oil rate required for the fractionating absorber's operation, a separate rich oil deethanizer may be used in place of the fractionating absorber. A rich oil deethanizer allows the primary absorber to be loaded to its maximum liquid handling capacity and thus set the maximum propane-proylene recovery obtainable as the deethanization of the rich oil is carried out in a separate column. The absorber of the gas plant shown in Figure 1 was found to be of the type mentioned above in that the liquid handling capacity of the absorber was the limiting factor and consequently this absorber could not be easily converted into a fractionating absorber. Figure 14 shows how

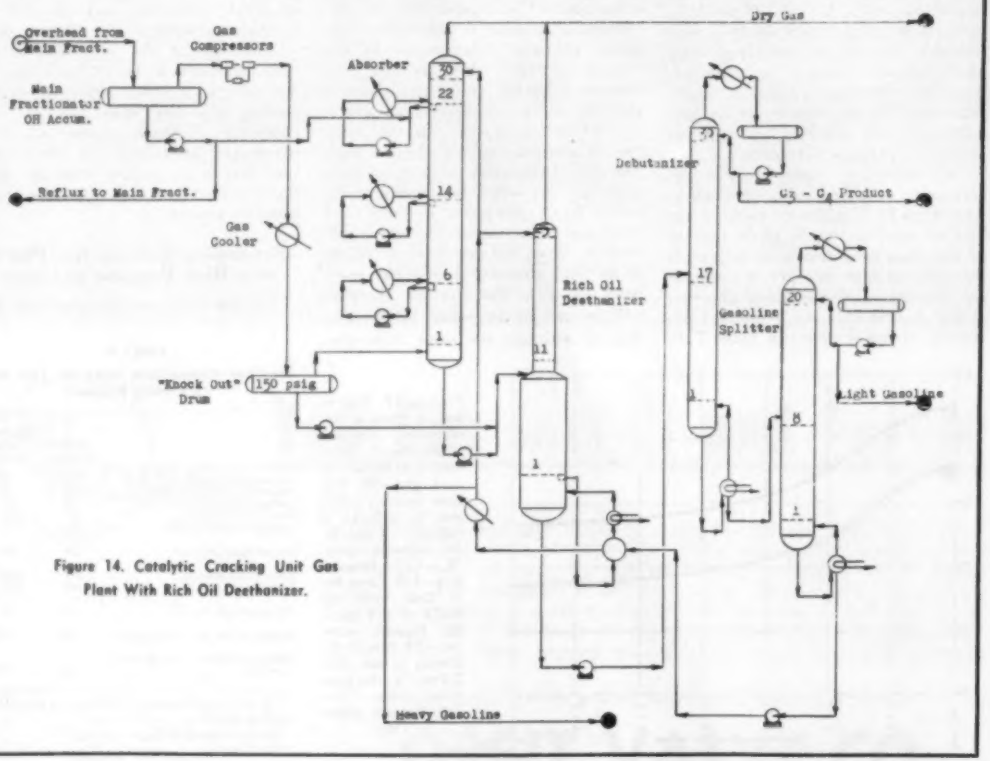

Figure 14. Catalytic Cracking Unit Gas Plant With Rich Oil Deethanizer.

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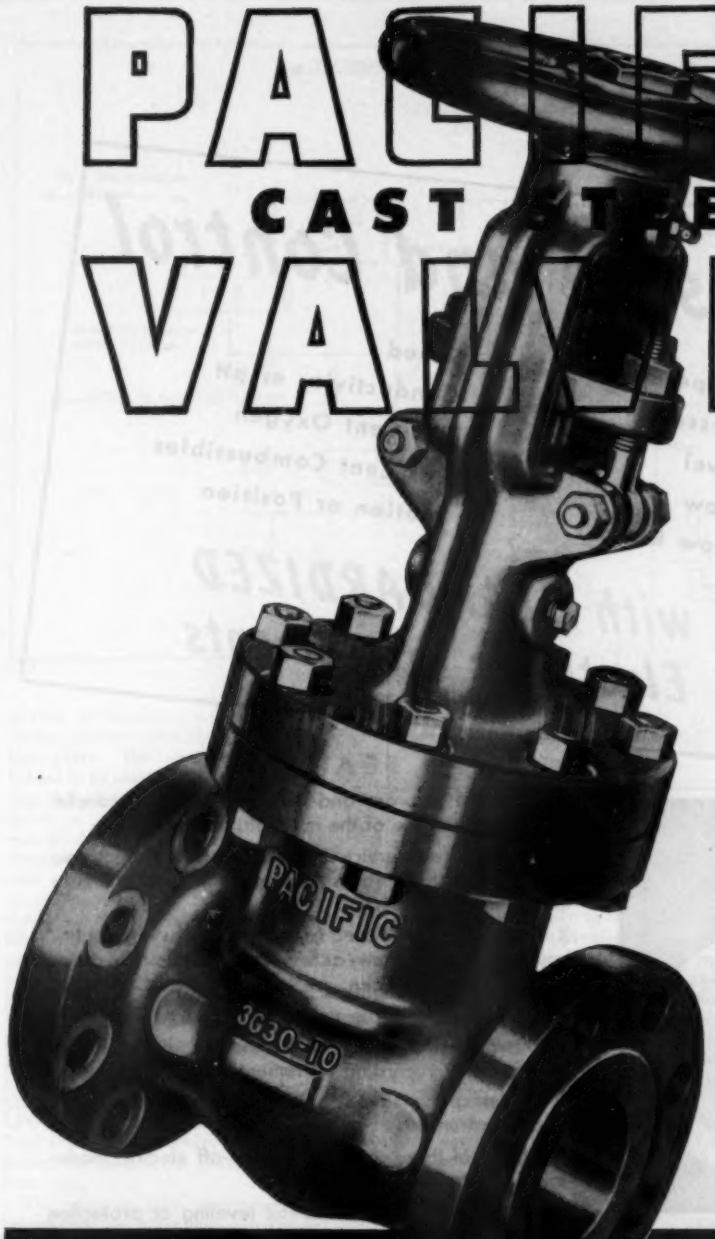

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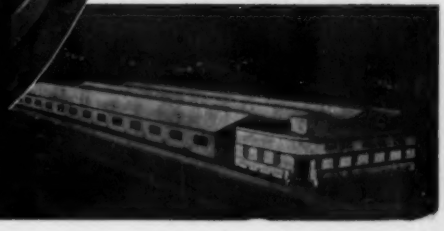

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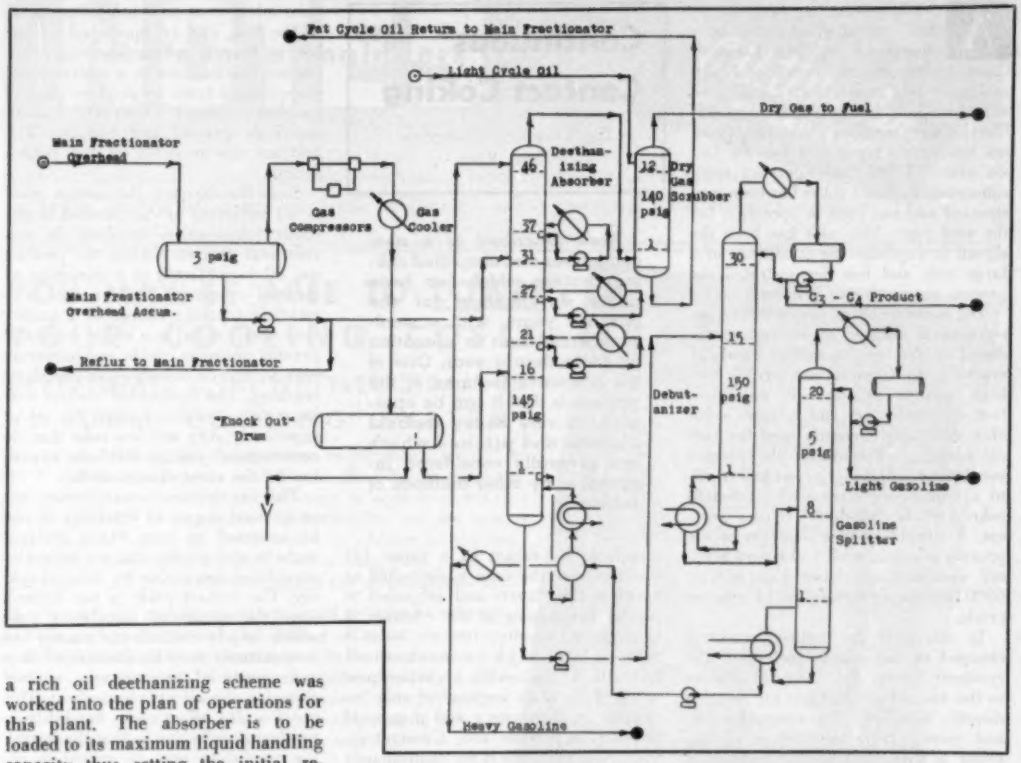


Figure 15. Modern Gas Plant for Catalytic Cracking Unit.

a rich oil deethanizing scheme was worked into the plan of operations for this plant. The absorber is to be loaded to its maximum liquid handling capacity thus setting the initial recovery of propane and propylene. The rich oil from the absorber is then deethanized in the rich oil deethanizer with a minimum loss of propane and propylene to fuel gas. The deethanization accomplished in the rich oil deethanizer is sufficient that the debutanizer overhead yield may be totally condensed at 125 psig, thus eliminating the previous recycle gas stream. The calculated recovery of propane for the unit revamped as shown in Figure 14 was 89.6 percent. The degree of deethanization of the C_3-C_4 product stream while not enough for LPG production or alkylation unit feed is very satisfactory for its intended use as catalytic polymerization unit feed.

The following table summarizes for the original gas plant shown in Figure 1 the calculated propane recoveries that would result from the revamped operations shown in Figures 1 and 14.

	Propane Recovery Mol. Percent
Original—Figure 1	65%
Revamped lean oil system—Figure 1	80%
Rich oil deethanization—Figure 14	90%

The exact choice as to which type or types of revamp to apply to a particular plant is a specific problem and must be treated individually for each plant under question. The final choice must be made from an economic as well as operational viewpoint. In the case shown above the estimated cost in going from 80 to 90 percent recovery is many times as much as the cost that was incurred in going from 65 to 80 percent recovery. While this additional cost may be justified for one plant, another plant may find the cost too great for the second step and advantageously choose to operate at 80 percent recovery.

Conclusion

In addition to the above considerations, other factors such as the compressor horsepower costs, plant investment, corrosion problems, value of the product, and the availability and cost of fuel, steam and water also affect the choice of plant or type of revamp to be used. Often the cost of fuel gas in the plant's area will determine the optimum propane-propylene recovery figure. The capacity of the plant is still another factor to be coped with inasmuch as oversized or idle capacity is a costly item. All of the above factors as well as those factors governing the plants recovery must be carefully considered and studied before the economic optimum design can be determined.

The design of a modern gas plant, representing probably the latest trend in such plants, is shown in Figure 15. This plant has been designed to recover 90 percent of the total C_3's with a negligible loss of gasoline boiling range hydrocarbons to the fuel gas. Salient features of this design are the use of a deethanizing absorber, a low molecular weight primary lean oil, adequate sponge oil facilities, and the elimination of all recycle gas streams from the fractionating equipment.

REFERENCES

[1] Hannah, J. C., Petroleum Refiner, Vol. 28, No. 8, August, 1949.

[2] Goldblatt, S. and Nelly, Jr., H. M., Petroleum Refiner, Vol. 28, No. 11, November, 1949.

Continuous Contact Coking

The Lummus Company,
New York

Here described is a new continuous and simplified coking process which has been under development for the past six years, with a semi-commercial unit in operation for more than a year. One of the attractive features of the process is that it can be operated on very heavy residual asphalts and pitches which are generally considered inoperable by other methods of coking.

A NEW continuous and simplified coking process has been developed by The Lummus Company for the conversion of heavy residuum oils and tars into coke and valuable light hydrocarbon products. Development work on this coking process has been carried out for the last six years. A 100-barrel-per-day semi-commercial contact coker has been constructed and has been in operation for the past year. This unit has been designed to duplicate the conditions of a large unit and has demonstrated the process in conclusive fashion.

The contact coking process offers an economical method of converting reduced crudes into maximum yields of cracking stock readily convertible into high quality gasoline. It minimizes fuel oil production and releases valuable distillates currently used for fuel oil blending. Essentially the process consists of applying a residual stock to a continuous stream of preheated coke particles produced in the process. A simplified flow diagram of the process is shown with yields and product specifications from processing 6500 barrels per stream day of reduced crude.

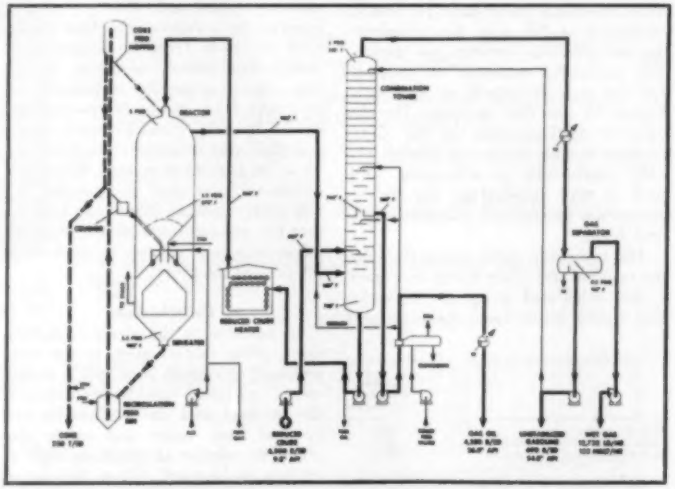
In this unit the reduced crude is charged to the bottom section of the synthetic tower. Any material boiling in the desired product gas oil range is directly distilled. The reduced crude and recycle from the bottom of this tower is preheated in a conventional oil heater to a normal temperature of 800 to 850° F. The preheated oil charge is then thoroughly contacted with the circulating stream of preheated coke particles. The contacting zone is located at the top of the reactor. The temperature of the wetted coke after application of charge oil may be varied from 850° F. to over 1000° F. by changing the preheat or the rate of circulation of the coke. The hydrocarbon oils are distributed uniformly on the coke as a thin liquid microfilm without agglomeration of the circulating solids. The wetted coke particles flow uniformly through the reactor as a bed of free particles. The solids residence time in the reactor may be varied from 15 to 40 minutes, allowing the coking reaction to proceed gradually to complete conversion of liquid hydrocarbon to product vapors and dry coke. The coke is deposited as a very thin layer on the original coke particles. The coke stream passes from the bottom of the reactor through a sealing zone into a reheater, where it is heated by radiation and convection to the proper temperature for recirculation to the oil feed contact zone. The coke is recirculated by means of a vapor lift system. Since the coke is deposited as multiple thin layers and subjected to partial calcination in the reheater, it is high in density, low in volatile matter, and high in mechanical strength. As the coking operation proceeds, there is an increase of coke inventory in the system and a general increase in particle size. Constant inventory is maintained by continuously drawing off a net coke product stream of the largest particles.

The vapors from the reactor are removed at the top, adjacent to the coke inlet, or at an intermediate level in the bed, and are quenched by the heavier recycle stream. The vapors are further fractionated in a conventional low-pressure tower to produce gas and gasoline overhead, 400 to 900° F. boiling-range gas oil and bottoms. The bottoms are recycled to the coking reactor.

Since the charge to the contact coker is not subjected to the elevated heater outlet temperatures involved in conventional delayed coking, the product gas oil is subjected to a minimum of thermal cracking. This results in a catalytic cracking charge of a quality very nearly equal to a virgin stock and permits optimum yields and minimum coke formation on subsequent catalytic cracking. The continuous contact coking process produces more gas oil of superior quality and less coke than do conventional coking methods operating on the same charge stock.

The continuous contact coker has an unusual degree of flexibility. It can be operated on very heavy residual asphalts and pitches that are generally considered inoperable by delayed coking. The contact coker is not limited, since the stream of circulating coke which largely controls the reactor bed temperatures may be maintained at a wide range of temperatures without changing the oil charge preheat. This process also offers more flexibility in product distribution in that the operating conditions may be varied to obtain a high degree of cracking. When operating at low temperature levels minimum coke production is obtained.

Flow Chart of Continuous Coking Process. (Courtesy, The Lummus Company, Reprinted from "Petroleum Horizons.")



NOTES for Process Engineers

C. H. Wheeler OF PHILADELPHIA

COOLING TOWERS—VACUUM REFRIGERATION—HIGH VACUUM PROCESS EQUIPMENT—MICRO-PARTICLE REDUCTION MILLS—STEAM CONDENSERS—STEAM JET EJECTORS—MARINE CONDENSERS & EJECTORS—DECK MACHINERY

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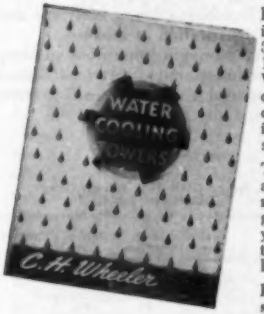

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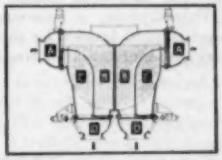

Both halves work the same but independently of each other. Left Side: Water enters divided water box at valve chamber A, with upper port open. It flows through pass B to end of condenser, back through pass C and out through left port of D.

Right Side: Flow is reversed: Valves at inlet A and discharge D are changed to permit water to flow through C and back through B in the opposite direction, then out through lower port of D.

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Production of Ethylene From Petroleum Sources

Part I

PETER W. SHERWOOD,
Chemical Engineer, Pittsburgh

ETHYLENE provides to the processor one of the major links between petroleum and organic chemicals. Ethylene obtained from the cracking of ethane and propane, and from refinery gases, is now consumed in huge quantities to produce ethylene glycol, ethyl alcohol, styrene, polyethylene, and other chemicals. In all, it has been estimated that ethylene production from petroleum sources has risen from 166 million pounds in 1943 to 1180 million pounds in 1948, with further large increases within the past three years.

This article begins a three-part series on ethylene production from petroleum sources. Included in the study are petroleum sources of ethylene, pyrolysis of petroleum materials to produce ethylene, and separation and purification of ethylene, and separation and purification of ethylene by the various commercial processes.

AS A RAW material for the manufacturer of petrochemicals, ethylene is today without peer. The growth of its production during the past decade has closely paralleled the expansion of the petroleum-chemical industry.

The spectacular increase experienced during recent years in the consumption of ethylene continues unchecked as the list of its chemical derivatives and the scope of their usefulness grows. The valuable antifreeze and chemical functions of ethylene glycol have rocketed it from 151 million pounds production in 1941 to 439.7 million pounds in 1949, accounting for an increase of some 204 million pounds in the ethylene market. During the same period, styrene production rose from negligible quantities to 631 million pounds, with an annual ethylene consumption of 205 million pounds. Other major derivatives include ethyl halides and polyhalides which are produced from both ethylene and ethane.

Particularly striking have been the inroads of ethylene into the ethanol industry. While the entire 1931 output of ethyl alcohol was based on fermentation methods, the year 1948 saw a synthetic alcohol industry based on ethylene which accounted for 66.7 percent (about 100 million gallons) of the total American ethanol output.

Polyethylene, a newcomer to the plastics field formed by the high-pressure polymerization of ethylene, promises to contribute to the future strength of the ethylene market. Other ethylene derivatives, among them propionaldehyde and specialty lubricating oils are on the threshold of industrial production and offer potentially important markets.

In all, it has been estimated[20] that ethylene production from petroleum sources has risen from 166 million pounds in 1943 to 755 million pounds in 1948. This latter figure is supplemented by some 425 million pounds petroleum ethylene used for ethanol synthesis.

Sources of Ethylene

As a breakdown product of numerous thermal processes, ethylene is found in a variety of natural and industrial gases. Recovery from such sources is today being practiced quite widely by methods to be discussed in a later section of this paper.

Insufficiency of byproduct ethylene supply in many localities, which are suitable as synthesis plant sites from other considerations, has led to the augmentation of this resource by the conversion of paraffinic hydrocarbons. Principal raw materials for the industrial production of ethylene are gaseous paraffins, notably ethane and propane, which find their most useful employment in this conversion. Higher hydrocarbons can be, and have been, converted to ethylene whenever economic conditions allow.

An insight into the potentialities of various typical byproduct gases as a source of ethylene can be gained from Table 1 which lists the natural ethylene content and the potential ethylene yield from such sources. The calculated ethylene potential assumes conversion of the entire C_2 to C_4 content by industrially successful thermal cracking methods.

The bulk of the world's ethylene is derived from such byproduct gases and from preferential hydrocarbon cracking and dehydrogenation processes. In addition, significant amounts of this olefin have been produced by the partial hydrogenation of acetylene and by the dehydration of ethanol.

Under economic conditions existing in the United States, acetylene cannot be produced for less than 7.9 cents

TABLE 1
Some Typical Gaseous Sources of Ethylene

A. Petroleum Refinery Gases[1] Composition (Vol. %)

	Mixed-Phase Cracking	Reforming	Vapor-Phase Cracking	Poly-forming	Catal. Cracking
Hydrogen	2	7	7	7	7
Methane	35	40	30	50	18
Ethylene	3	4	23	6	5
Ethane	20	18	12	25	9
Propylene	7	6	14	3	16
Propane	15	10	4	6	14
Isobutane	2	3	1	..	16
n-Butane	8	7	2	1	5
Butenes	7	5	6	..	10
Butadienes	..	..	1	..	..
Potential Ethylene Yield, Lbs./M Cu. Ft.	31	27.9	37.0	25.2	37.3

B. Sources Other Than Refinery Gases (Composition Vol. %)

	Coal Gas	Coke-Oven Gas	Oil Gas	Producer Gas
Methane	34.0	28.5	27.0	2.6
Ethylene	6.6	2.9	2.7	0.4
Carbon Monoxide	9.0	5.1	10.6	22.0
Carbon Dioxide	1.1	1.4	2.8	5.7
Hydrogen	47.0	57.4	53.5	10.5
Oxygen	..	0.5	..	..
Nitrogen	2.3	4.2	3.4	58.8

per pound. At this price, it does not, of course, constitute a suitable raw material for ethylene which has an average value of 4.5 to 6.5 cents per pound. The situation is, however, different in oil-poor countries in which the cost of ethylene may be appreciably higher. Thus, acetylene hydrogenation was the main source of ethylene in wartime Germany while supplemental quantities were manufactured from ethanol and recovered from coke-oven gas. Only a comparatively small portion of the total German ethylene output was derived by thermal cracking and partial oxidation of ethane. The very elegant processes which have been developed for the partial hydrogenation of acetylene hold potentialities in the United States only for the removal of trace acetylene. They will be discussed later in connection with ethylene purification by absorption in solutions of copper salts.

Ethanol dehydration, on the other hand, is even today a significant source of ethylene. In 1942, more than 13 million pounds of ethylene were produced by this process while ethanol dehydration plant capacity in 1948 is estimated at nearly twice this amount. The economic success of the process depends on conditions and requirements encountered locally. Because of relatively low investment costs, this manufacturing method is particularly suitable where ethylene is required in small quantities. Ethyl alcohol is considered a particularly practical form for the shipment of ethylene. It is by no means unusual to hydrate ethylene in Texas, ship the product ethanol to the East and reconvert it there to ethylene. This procedure eliminates the need for high-pressure containers and reduces the total volumes handled in shipment.

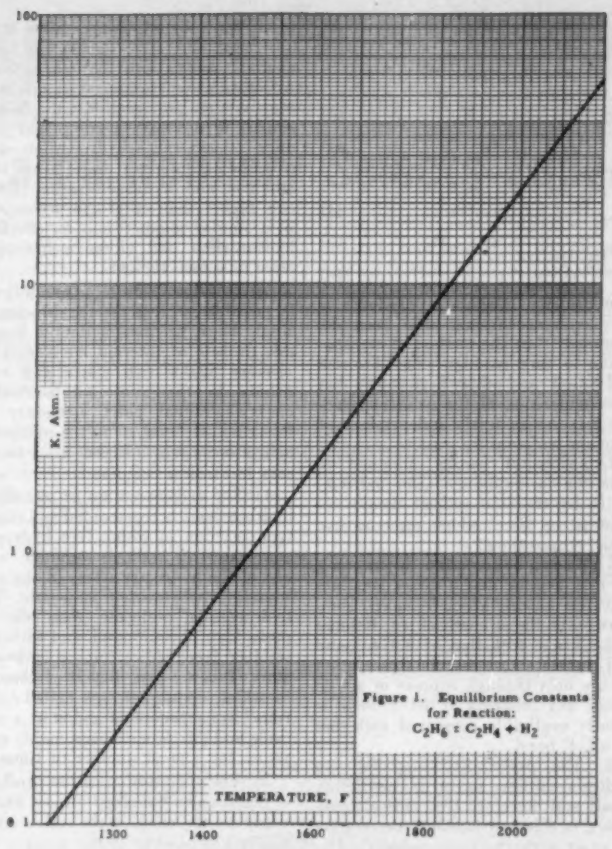


Figure 1. Equilibrium Constants for Reaction: $C_2H_6 \rightleftarrows C_2H_4 + H_2$

Chemistry of Ethylene Production by Pyrolysis

Thermodynamically all paraffinic, olefinic, or naphthenic hydrocarbons constitute a suitable starting material for the production of ethylene by pyrolysis. In actual practice, however, the field is greatly narrowed by economic and yield considerations, and the greater portion of America's manufactured ethylene is derived from gaseous paraffin stocks.

Methane, characterized by high thermal stability and the absence of a carbon-to-carbon linkage has resisted all of the many attempts to convert it to ethylene with commercially attractive results. Yields not exceeding 4 percent were obtained by de Rudder and Biedermann[2] at 1200° C. and 100 mm Hg. pressure. Similar yields have been obtained by other investigators, although Storch[3] was able to obtain very high yields of ethane and ethylene by the pyrolysis of methane with electrically heated filaments submerged in bulbs cooled to —183° C. Storch's work indicates that the primary product of methane pyrolysis is ethane which is further dehydrogenated to ethylene. The virtue of the apparatus employed in these experiments was the removal of the primary products of pyrolysis from the reaction zone immediately upon formation, thus avoiding the secondary and tertiary reactions which accompany all hydrocarbon pyrolyses and which are exceedingly rapid at the high temperatures required for the thermal breakdown of methane.

Ethane is theoretically the ideal charging stock for the manufacture of ethylene. If carried out at suitable operating conditions, the dehydrogenation reaction

$$C_2H_6 = C_2H_4 + H_2 \qquad (1)$$

is accompanied by a minimum of primary side reactions and yields as high as 89.6 percent have been reported.[4] Equilibrium values for reaction[1] have been determined by a number of investigators[4,5,6] and are plotted in Figure 1. It must be emphasized that one cannot speak of a "true equilibrium" in this connection because the primary products tend to undergo secondary pyrolytic reactions to form acetylenic and aromatic compounds, and eventually methane, carbon, and hydrogen.

As the paraffin chain of the charge stock is lengthened, an increasing number of primary pyrolytic reactions can take place and the maximum yield of ethylene decreases accordingly. Thus the pyrolysis of propane can take place by two reaction routes, while

the breakdown of butane can take three paths:

Pyrolysis of Propane:

$$CH_3CH_2CH_3 \rightleftharpoons CH_3 = CH_2 + CH_4 \quad (2)$$

$$CH_3CH_2CH_3 \rightleftharpoons CH_3CH = CH_2 + H_2 \quad (3)$$

Pyrolysis of Butane:

$$CH_3CH_2CH_2CH_3 \rightleftharpoons CH_3 = CH_2 + C_2H_6 \quad (4)$$

$$CH_3CH_2CH_2CH_3 \rightleftharpoons CH_3CH = CH_2 + CH_4 \quad (5)$$

$$CH_3CH_2CH_2CH_3 \rightleftharpoons CH_3CH_2CH = CH_2 + H_2 \quad (6)$$

The primary breakdown products of various hydrocarbons have been determined[7,11] by the method of extrapolation to zero reaction time. Tropsch and Egloff[8] and others have shown that the composition of the primary product mixture is fairly independent of reaction temperature.

Experimental results obtained to date can be explained quite satisfactorily by the free radical theory developed by Rice[9] which rests on five basic propositions:

1) When a hydrocarbon decomposes, we may assume that it dissociates into two free radicals which fly apart. Comparison of the strength of a C-H bond (93.3 kcal) with that of a C-C bond (71.0 kcal) shows that the dissociation occurs only through rupture of a C-C bond; any breaking of a C-H bond is wholly negligible compared with that of a C-C bond.

2) The probability that the two radicals collide again is negligibly small and therefore free radicals produced in this way can only decompose or react with the surrounding hydrocarbon molecules. E.g., a free methyl group can take a hydrogen atom from the surrounding hydrocarbon and form methane and a hydrocarbon radical. An ethyl group produced in this way can undergo two reactions: the first is similar to the methyl group and produces ethane and a hydrocarbon radical; the second is a dissociation into ethylene and hydrogen atoms. Radicals higher than ethyl can decompose in a similar manner into an ethylene hydrocarbon and either a hydrogen atom or a free radical.

3) This dissociation of free radicals is possible because, in the process, a single bond becomes a double bond; this process of internal compensation releases 52,800 cal. which can contribute to the minimum activation energy (93,000 cal.) necessary to break a C-H bond, or to the minimum activation energy (71,000 cal.) necessary to break a C-C bond.

4) The decomposition of paraffinic hydrocarbons is represented as a chain-type reaction in which free hydrogen atoms or free radicals combine with one of the hydrogen atoms of the surrounding hydrocarbon molecule. The hydrocarbon molecule then decomposes into a compound and either a smaller free radical or a hydrogen atom. Thus we have a cycle of changes in which certain groups called "carriers" are regenerated and start a new cycle and this process presumably may go on for a great number of times.

5) The composition of the products is determined therefore almost exclusively by the chain cycle and is practically independent of the primary decomposition of the hydrocarbon. It is possible to calculate the composition of the products when a hydrocarbon is allowed to decompose to a small extent. In these calculations, all primary C-H bonds are considered to have the same strength, all secondary C-H bonds 1200 cals. less, and all tertiary C-H bonds 4000 cals. less than a primary C-H bond. The only arbitrary assumption made in the calculation is the assignment of the relative strengths to the different classes of C-H bonds.

A comparison of calculated values with experimentally determined primary breakdown products of various hydrocarbons proves a good test of Rice's theory. For instance, n-butane was found by Neuhaus and Marek[7] to yield a primary product ratio

$$\frac{\text{Ethane} + \text{Ethylene (Eq. 4)}}{\text{Methane} + \text{Propylene (Eq. 5)}} = .71 \text{ (at } 600^\circ \text{ C.)}.$$

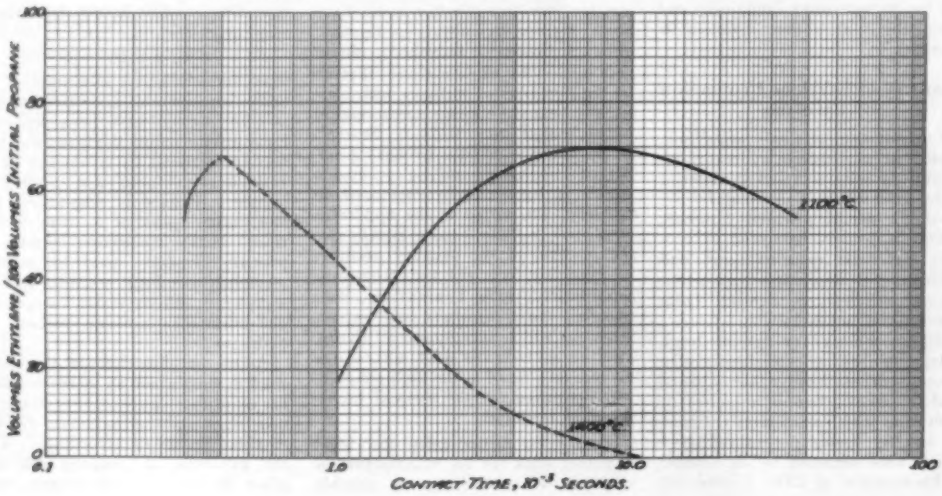
Rice's theory predicts a ratio of .75 at the same temperature.

As is true in all cracking reactions, a serious engineering problem is raised by the appreciable endothermic heats of reaction involved. This consideration influences the furnace design significantly, as will be seen later. Thus, the conversion of ethane to ethylene absorbs 32,000 cals. Equation (2) requires 16,100 cals. while equation (4) calls for 17,000 cals.

Effect of Operating Variables

The industrial success of pyrolytic methods for the production of ethylene from other hydrocarbons rests largely on close control of the principal operating variables. The reason for this is

Figure 2. High-Temperature Pyrolysis of Propane. Effect of Contact Time. (Ref. 8.)



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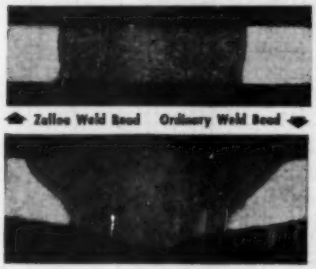

Zallea Weld Bead Ordinary Weld Bead

analyzing the many known welding processes, adopted an exclusive variation of the Heliarc process and added a grain refining procedure to the finished weld. In hundreds of brutal flexing tests, not one failure occurred within 30 degrees of the weld line! More important was the fact that these bellows lasted 4 to 8 times longer than bellows having a shielded arc welding bead. Note the exclusive Zallea controlled welding technique as compared to the welding procedure used in other flexible connectors. When you want the best in flexible connectors, always specify Zallea...you'll find it pays!

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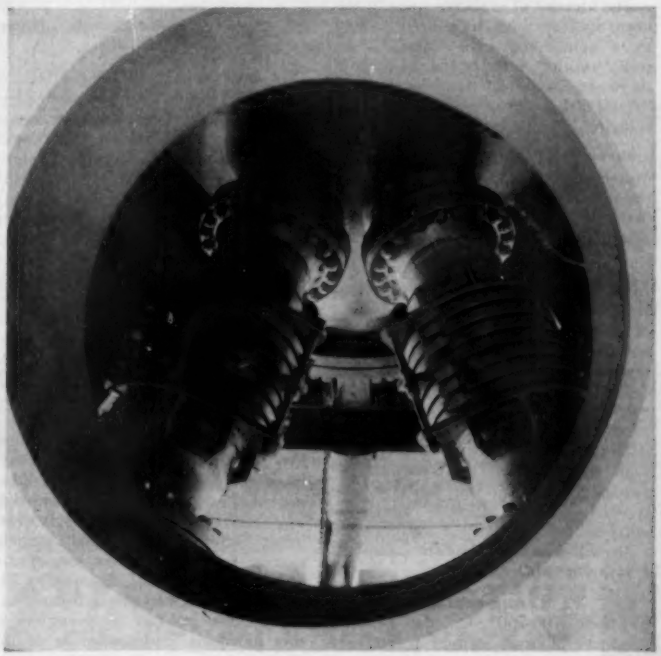


amply evident from the large number of primary reactions which are possible, especially when some of the higher hydrocarbons are pyrolized, and from the instability of ethylene at the required reaction temperatures.

Contact Time

At any given temperature, reaction time is probably the most significantly influential variable affecting the overall ethylene yield. Primary and secondary ethylene-forming reactions are opposed by ethylene breakdown. Optimum contact time will yield a sharply pronounced maximum ethylene yield. The proper contact time is an inverse function of operating temperature and of molecular weight of the charging stock. Figure 2, based on work by Tropsch and Egloff[9] is a striking illustration of the effect of reaction time on ethylene yield in the high-temperature pyrolysis of ethane and of propane at 1100° C. and 1400° C. (50 mm pressure). As the contact time for maximum ethylene production is exceeded, the acetylene and carbon yield curves rise rapidly at the expense of ethylene. Optimum commercial operation should actually be carried out at an even shorter reaction time than is necessary for maximum per-pass-conversion. Unconverted feedstock can be separated from the reaction products and recycled to the pyrolysis stage for maximum overall yield.

The kinetics of cracking some of the lower hydrocarbons have been studied by a number of investigators. Most recent results[4] reported for the pyrolysis of ethane indicate that the primary breakdown is a first-order reaction the velocity of which follows the equation:

$$\log_e K = 14.02 - (69{,}700/2.3\,RT) \quad (7)$$

Marek and McCluer[10] find that the thermal dissociation of propane at 600-700° C. is satisfactorily represented by the equation:

$$\log k = 13.44 - 13{,}500/T \quad (8)$$

According to this work, the principal reactions in the thermal decomposition of propane, dehydrogenation and demethanization, take place at approximately the same rates at 6-700° C.

Figure 3[11] traces the progress of product formation in the pyrolysis of propane. The conversion to ethylene is found to climb steadily. After more than 35 percent of the feedstock has reacted, ethylene is, however, destroyed at a rate which is faster than ethylene genesis, and the overall yield of useful product therefore passes its maximum value quickly.

Temperature

Above 700-750° C., the primary products of hydrocarbon pyrolysis have been repeatedly (e.g. Ref. 8) shown to be substantially independent of the operating temperature within fairly wide limits. On the other hand, the secondary reactions are a definite function of this variable. As a result the effect of raised temperature and of prolonged contact time are to a certain extent interchangeable in the production of ethylene from petroleum stocks. As shown by Frolich and Wiezevich,[12] ethylene yield passes through a steep maximum as the temperature is raised and the time of exposure is maintained constant. The general shape of the yield curve is similar to Figure 2, except that the abscissa reads "temperature" instead of "Contact Time." In the pyrolysis of n-butane with an exposure time of 0.4 seconds, a maximum ethylene content in the product gas of 28.8 percent was obtained at 730° C. The propylene content, which never exceeded 11.5 percent began to decline at an even lower temperature (660° C.), opening the way to the conjecture that ethylene is formed as a degradation product of propylene in this pyrolysis. Substantiation of this interpretation has been found in other studies on the pyrolysis of pure olefins.[13]

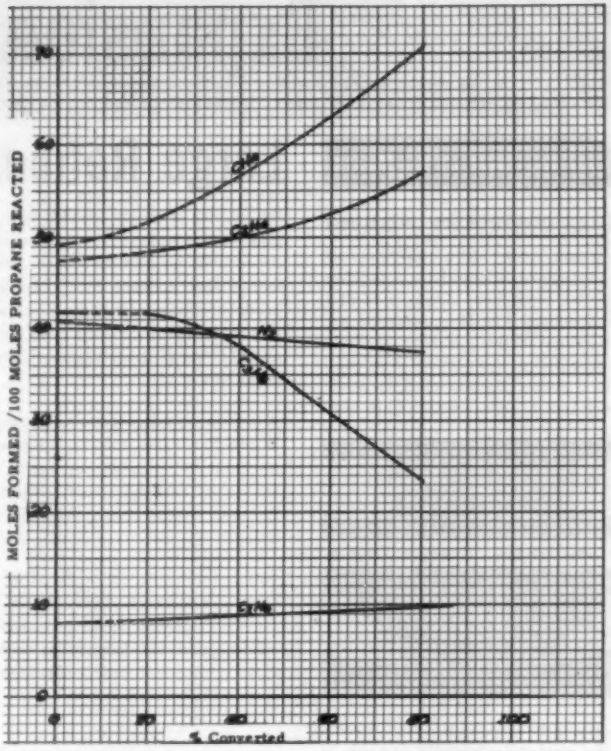
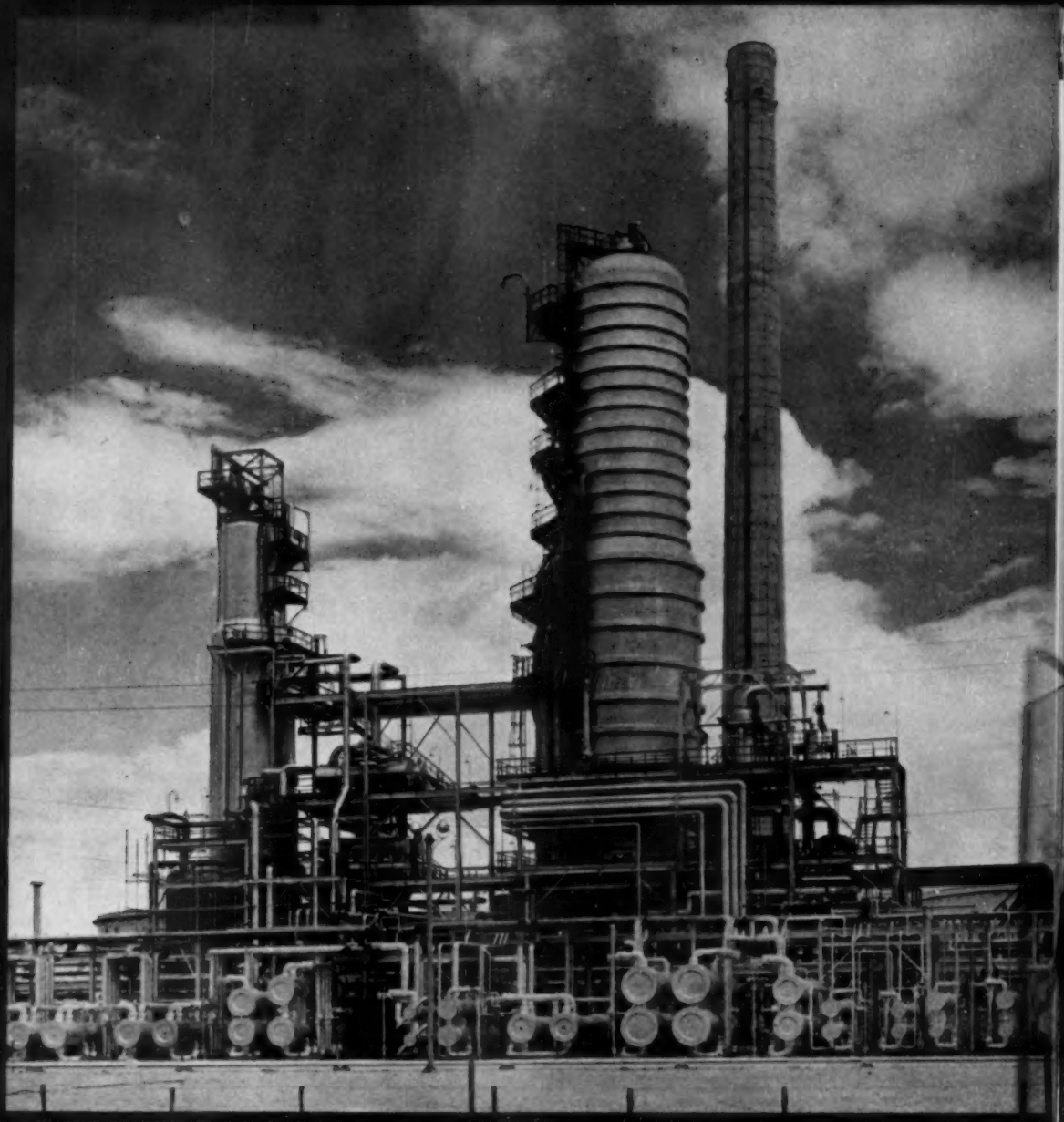


Figure 3. Pyrolysis of Propane. Progress of Reaction. (Ref. 11.)

More drastic conditions are required for optimum production of ethylene from feedstock of lower molecular weight. In the case of propane, Frolich and Wiezevich[12] obtained a maximum ethylene concentration of 29.4 percent at 890° C., using the same contact time as in the case of butane pyrolysis.

Pressure

Ellis[14] points out that the primary decomposition reactions of paraffin hydrocarbons are homogeneous and first order, and that pressure should therefore have no significant effect on their velocity and progress. This conclusion has been substantiated experimentally by Munday at pressures ranging from 0.1-1.0 atmospheres.[15] Nevertheless, operation at elevated pressures is undesirable because of the increased tendency of the primary products to undergo bimolecular condensation and polymerization reactions at the cost of ethylene yield. Commercial hydrocarbon pyrolysis for preferential ethylene



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production is generally carried out below 30 psig.

The use of various diluents, notably of steam, has been proposed in the patent literature to lower the partial pressure of the reactants. This approach to pyrolysis is not uncommon and is operated quite successfully. As will appear from the later discussion of commercial processes, the diluent can also be made to serve the secondary purpose of supplying the necessary heat of pyrolysis.

Catalysts

While catalysts have been used successfully for the dehydrogenation of butane and propane to the corresponding olefins, no catalyst has so far been developed which promotes satisfactorily the dehydrogenation of ethane or which accelerates preferentially the thermal breakdown of higher hydrocarbons to ethylene and byproducts. There is evidence that some catalysts (e.g. iron-chromium oxide mixtures with various promoters) lower the required reaction temperature by as much as 350° F. without seriously affecting the reaction progress picture. Secondary decomposition reactions are generally responsible for an early deactivation of such catalysts and there is a tendency on the part of such contact materials to accelerate the complete breakdown (carbon formation) more significantly than the desired primary reactions. Thus, this writer knows of no commercial installation for the preferential production of ethylene by the catalytic breakdown of higher hydrocarbons.

Miscellaneous

Cambron and Bailey[16] have shown that pyrolysis under conditions of turbulent flow results in better yields (in the laboratory) than can be obtained in laminar flow. The phenomenon is probably intimately associated with heat transfer considerations, i.e., turbulent flow tends to minimize the formation of a slowly moving, superheated gas film at the reactor wall—a film which is certainly subject to extensive breakdown reactions of the primary products.

Partial Oxidation of Ethane

Ethylene has been produced in a large-scale installation at Leuna, Germany, by the partial oxidation of ethane. The process has the drawback of requiring oxygen of fairly high (95 percent) purity and of yielding cracked gases which contain appreciable quantities of carbon monoxide plus lesser amounts of other contaminants. The process is favored by the relative simplicity of reactor design which is made possible by the elimination of an external heat source. Moreover, since product hydrogen is burned preferentially in a properly executed partial oxidation process, the ethane-to-ethylene decomposition equilibrium is shifted to the dehydrogenation side and higher conversion per pass can be achieved than is possible in purely thermal processes.

The objective of the process is to break down ethane to ethylene and hydrogen pyrolytically and to consume hydrogen immediately upon formation by reacting it with oxygen without destroying the product olefin.

It has been found by Pease[17] and others that the combustion of hydrocarbons can be inhibited by increasing the amount of wall surface available to the system. This phenomenon has been explained by Lewis and von Elbe,[18] according to whom the first step in the hydrocarbon oxidation is the relatively slow formation of an aldehyde which is then further oxidized to a peracid RCOOOH. Breakdown of the peracid may result in the radicals RCOO and OH or in the molecules RCHO, water and carbon dioxide. The radicals formed by the first alternative are capable of combining with a molecule of hydrocarbon, thus continuing the chain which leads to complete oxidation. On the other hand, the second breakdown reaction available to the peracid terminates the reaction chain and further hydrocarbon combustion is made dependent on the continued slow direct oxidation which initiates the whole process. It appears that the presence of a large surface favors peracid decomposition to the stable aldehyde, and thus tends to minimize the combustion of hydrocarbon. The oxidation of hydrogen, on the other hand, is not subject to any such surface effect. By carrying out the partial combustion in the presence of large surfaces, it is therefore possible to oxidize byproduct hydrogen selectively and to minimize the destruction of ethane and ethylene.

In commercial practice, which will be discussed in more detail in a later section, the reactor is filled with 1¼-inch ceramic spheres which are found to present sufficient surface for the purposes of the process.

The effect of process variables in the selective oxidation of ethane has been studied by McCullough and Walton[19] in exploratory runs. The reaction was carried out in the presence of a dehydrogenation catalyst and oxygen was injected at various points along the path of gas travel. The selectivity (a measure of over-all ethylene yield) was found to be lowered by raising the oxygen content, while the conversion per pass was increased as must be expected from equilibrium considerations set forth above.

The effect of contact time and of temperature is quite similar to the influence of these variables in purely thermal dehydrogenation (see above). A very pronounced maximum is obtained especially in the case of contact time. Excessive contact time results in large losses due to secondary carbonization and polymerization reactions while incomplete conversion is observed at insufficient contact times.

The effect of pressure is not quite clear. It appears, however, that a suitable adjustment of other conditions permits approximately the same conversion and selectivity regardless of the partial pressure of ethane in the subatmospheric range.

There appears to be no favorable effect of catalysts on the over-all yield of ethylene although, as in the case of straight cracking, a reduction in operating temperature level is possible. Active catalyst life is severely limited by the formation of carbonaceous deposits and other contaminants. Such coke deposits have also been observed on the ceramic packing of non-catalytic partial combustion reactors. In this case, the problems inherent in regeneration are negligible, however, and "down-time" is much shorter and at less frequent intervals than would be the case in catalytic operation.

End of Part I. Part II will appear in an early issue.

BIBLIOGRAPHY

[1] Sachanen, A. N. Conversion of Petroleum. 2nd ed., New York City (1948).
[2] de Rudder and Biedermann. Compt. rend. **190**, 1194 (1930).
[3] Storch, H. H. J.A.C.S. **54**, 4188 (1932).
[4] Hepp, H. J., Spessard, and Randall, J. H. Ind. Eng. Chem. **41**, 2531 ff. (1949).
[5] Storch and Kassel.
[6] Frey, F. E., and Huppke, W. F. Ind. Eng. Chem. **25**, 54 (1933).
[7] Neuhaus, M. and Marek, L. F. Ind. Eng. Chem. **24**, 400-2 (1932).
[8] Tropsch, H. and Egloff, G. Ind. Eng. Chem. **27**, 1063-7 (1935).
[9] Rice, F. O. J.A.C.S. **53**, 1959-72 (1931).
[10] Marek, L. F. and McCluer, W. B. Ind. Eng. Chem. **23**, 878-881 (1931).
[11] Schneider, V., and Frolich, Per K. Ind. Eng. Chem. **23**, 1405 (1931).
[12] Frolich, P. K., and Wiezevich, P. J. Ind. Eng. Chem. **27**, 1055 (1935).
[13] Schutt, H. C. Chemical Engineering Progress. **43**, 103-116 (1947).
[14] Ellis, C. The Chemistry of Petroleum Derivatives. Reinhold Publishing Corporation (1937), p. 149.
[15] Munday, J. C. Dissertation, Columbia University, 1934. Quoted by (14).
[16] Cambron, A., and Bayley, C. H. Can. J. Research. **9**, 178 (1933).
[17] Pease, R. N. J. Am. Chem. Soc. **51**, 1839-56 (1929).
[18] Lewis, B., and von Elbe, G. Combustion, Flames, and Explosion of Gases. Cambridge University Press (1938).
[19] McCullough, J. P., and Walton, J. S. Ind. Eng. Chem. **41**, 1455-1459 (1949).
[20] Buell, C. K., and Weber, L. J. Quarterly of the Colorado School of Mines. **45**, No. 2A, pp. 59-89 (April 1950).

ETHYLENE Manufacture By Cracking Process

The Lummus Company, New York

THE development of the petroleum chemical industry continues unabated since the close of World War II. In this field ethylene has played a very prominent role. Crude petroleum and natural gas do not contain ethylene. However, the off gas from refineries cracking petroleum stocks contain ethylene to considerable amounts, as much as 8 percent at times. The supply from this source alone is usually inadequate and not economically recoverable. From the recovery and purification of ethylene from refinery off gases, are obtained gaseous and liquid petroleum fractions which are suitable for selective cracking to specifically produce ethylene. The ethylene rich effluent combined with the refinery off gases compose the total fresh charge to the ethylene recovery and purification section. Most ethylene-producing petroleum-chemical plants use either ethane, propane, or a mixture of ethane nad propane as cracking charge.

The accompanying flow diagram illustrates a plant for the production of an ethylene rich effluent from the cracking of ethane, propane, or an ethane-propane mixture. In this process the ethane-propane feed is charged to the cracking heater. Conversion to ethylene is accomplished at reaction temperatures between 1460° and 1510° F. The heater effluent, containing 15-22 mol percent ethylene, is shock quenched by a water spray and further cooled in the quench pots by the circulating water system. The effluent from the quench pots is further cooled in shell and tube exchangers and compressed. Compression is to a level consistent with the subsequent processing scheme. Polymers and heavy aromatic distillate are condensed and are decanted in the quench water surge drum. Steam is generated from waste heat in the stack gas.

The cracking heaters for this plant must be designed to give the high temperatures and low residence times required for the desired conversion without causing overheating of the tubes or conditions leading to coke deposition in the tubes. The Lummus Company has developed a novel basic design to accomplish these objectives economically and has built more than fifteen heaters for service of this type. These heaters have proved the soundness of the design features by on-stream periods consistently exceeding 100 days.

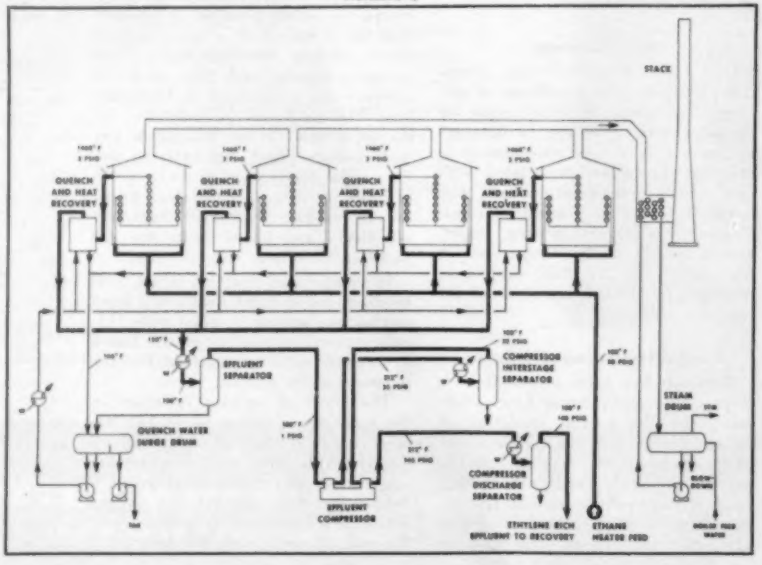
The recovery and purification of ethylene from refinery off gas and cracking effluent may be carried out by chemical or physical means. For the production of alcohol, the separation is made chemically by treating the ethylene rich gas directly with concentrated sulfuric gas. In this process the raw gas requires no pre-treatment except the removal of hydrocarbons heavier than ethane.

For the production of high purity ethylene, as required by certain synthesis, several processes are used for purification. Lummus has contributed to the distillation processing scheme with the development of the fractionating absorber and has built several units of this type.

In this process the feed—refinery off gas and effluent from ethane-propane cracking—is water cooled and partially condensed by refrigeration before it is charged to the fractionating absorber where methane and hydrogen is rejected overhead while ethylene and the heavier hydrocarbons are absorbed in the lean oil. The stripper separates from the fat oil all hydrocarbons through C_4, leaving lean oil which is cooled and recirculated to the absorber. The stripper overhead is dried and further fractionated. Refrigeration for the unit is supplied by a system using propane as the refrigerant.

In this process the separation produces an off gas consisting of the fixed gases, a high purity ethylene product, ethane, LPG and aromatic distillate and could be extended for the recovery of propylene if desired.

Ethylene Manufacture by Cracking Process. (Courtesy, The Lummus Company, Reprinted from "Petroleum Horizons".)



BENZENE is already in critically short supply and, in the event of all-out war, other aromatics, especially toluene and xylenes, will become "musts" for supplying both military and essential civilian requirements. Sun Oil Company announces a new process to separate aromatics which it designates as the Arosorb Process—a contraction of aromatic adsorption. The process is a commercial development of the analytical tool of silica gel adsorption. Operating on the product of a naphtha reformer, the process first makes a separation between saturants and aromatics, and then resolves the latter into benzene, toluene, and xylenes. The accompanying description of the process was prepared by engineers of Sun Oil Company.

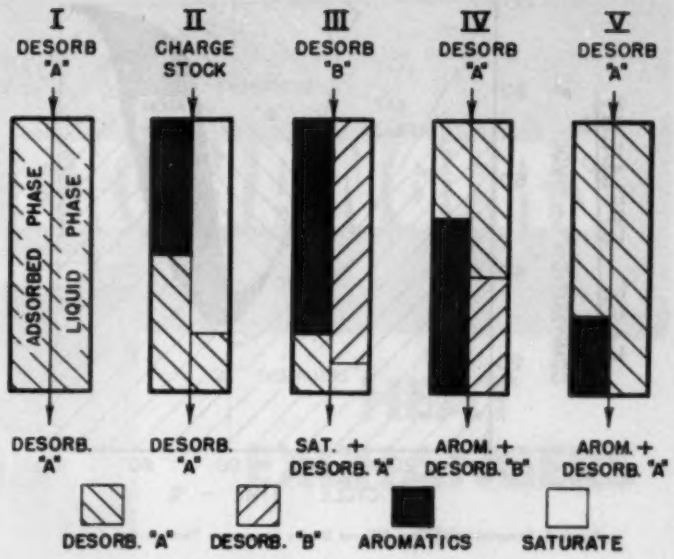


Figure 1. Graphical Representation of Adsorption Cycle for One Case.

AROSORB PROCESS for the Separation of Aromatics

A NEW process for the separation of aromatics has been developed by Sun Oil Company. Known as the Arosorb Process, it is a commercial development of the analytical tool of silica gel adsorption used so successfully by Dr. F. D. Rossini, of the American Petroleum Institute's Project No. 6 in his outstanding work on the analysis of petroleum. The present process has been under development for more than eight years.

The Arosorb Process will be incorporated in a new plant costing more than $8 million soon to be erected at Sun's Marcus Hook refinery. The new plant will operate on the effluent from a 10,000 barrel-a-day Houdriformer. From this charge, the new plant is designed to produce 13 million gallons per year of benzene, 30 million gallons per year of toluene, and 15 million gallons per year of xylenes.

Both Houdry Process Corporation and Universal Oil Products Company are being appointed as agents authorized to license the Arosorb Process under patent rights of Sun Oil Company.

The new process will be the first large scale commercial application of selective adsorption utilizing silica gel. Silica gel, which is a synthetic amorphous form of silica, possesses the property of "selective adsorption" with respect to aromatic and non-aromatic compounds. The grade of gel used offers a surface area for adsorption of about 90 acres per pound, thus providing a high capacity for adsorption.

Description of Process

In the process a stream containing the desired aromatics is passed through a bed of silica gel which retains the aromatic portion and allows the saturate portion to pass out the bottom of the bed. When the capacity of the gel for adsorption of aromatics has been reached, the feed is shut off and the gel bed desorbed. One of two desorbents washes out of the bed the residual saturate material from the charge stock and then the other desorbent gradually desorbs or displaces the aromatics adsorbed on the gel. When desorption is substantially complete, the charge stock is readmitted and the cycle repeated.

Figure 1 shows in some detail the steps involved in the cycle. At the end of one cycle, which is the start of the next, as shown in Diagram I, the entire case is filled with desorbent *A*. As indicated, this desorbent is present both in the adsorbed phase (schematically represented by the left-hand side of the diagram) and in the liquid phase (right-hand side of the figure). Diagram II represents the situation at the end of the charge stock period. The adsorbed phase (left) now contains the aromatics from the feed and approximately an equal amount of desorbent *A*. The liquid phase (right) is mainly the saturates originally present in the feed. The effluent from the case is substantially desorbent *A*.

Diagram III indicates the conditions prevailing after the addition of desorbent *B*, which serves principally to displace saturate materials from the

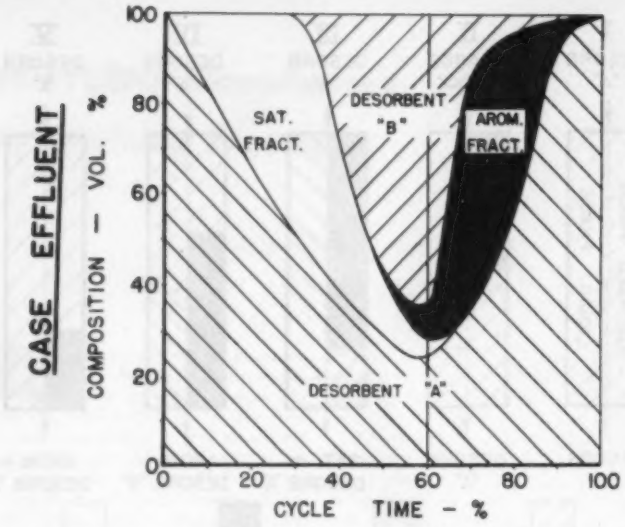


Figure 2. Composition of Case Effluent During Progression Through One Cycle.

liquid phase. Diagram IV reflects the effect of starting the addition of desorbent *A*. Here the aromatics from the charge stock are being displaced from the adsorbed phase along with desorbent *B* from the liquid phase. Diagram V shows what happens near the end of the desorption step. Almost all the aromatics from the charge have been displaced and the case is again nearly full of desorbent *A*. The next step will be a complete return to the conditions prevailing in Diagram I and the start of a new cycle.

In actual operation the flow through the case is continuous and there is a gradual increase and decrease of the various components in the effluent. This is pictured by the diagram in Figure 2 which gives the composition of the effluent at all points throughout the cycle. In this example, the product would be diverted from the saturate effluent receiver to the aromatic one at approximately 60 percent of the cycle. Figure 3 gives a plot of the refractive index of the effluent against percent of cycle to show how readily the course of the cycle may be followed and controlled by suitable instrumentation as discussed later.

Since the aromatic and saturate streams both contain desorbents *A* and *B*, they are each sent to two distillation towers to recover these desorbents.

Figure 4 is a flow sheet of the process approximately as it will be applied in Sun's Marcus Hook Refinery. For simplicity, only one of the several gel cases is shown. The feed stock and the two desorbents enter the top of the case in suitable sequence through the inlet manifold. The saturate effluent flows to a train of two distillation columns in the first of which desorbent *B* is removed as an overhead product and recycled. The saturate portion of the charge is recovered overhead in the second fractionator, with desorbent *A* as a bottoms which is also recycled.

The aromatic effluent is similarly handled except that, since a mixture of benzene and toluene will be processed, a third tower is added to the train to act as a benzene-toluene splitter. Naturally the precise sequence of recovery can be altered to suit the convenience or economic situation of any particular refiner.

Desorbents *A* and *B* are hydrocarbon streams having boiling points different from those of the charge stock. In Sun's plant desorbent *A* will consist of mixed xylenes and desorbent *B* will be butane. About two barrels of desorbent *A* and 0.5 barrels of desorbent *B* will be required per barrel of charge or, by analogy with solvent refining, a solvent dosage of 250 percent. However in the Arosorber, four-fifths of the "solvent" is taken as a bottoms product and does not need to be distilled.

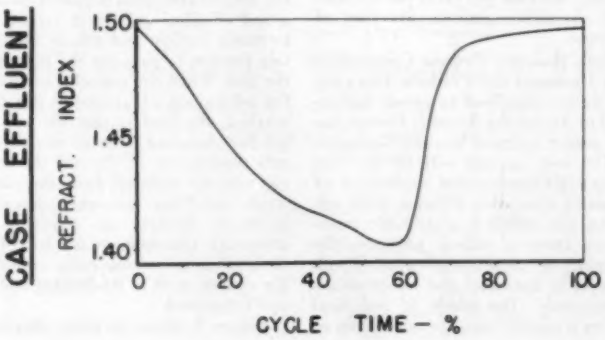
The figures above are for a feed containing 35 percent aromatics. The ratio of desorbents to charge would decrease with a lower-aromatic content feed and increase with a higher aromatic feed.

The Sun unit will have six silica gel cases ten feet in diameter and about 20 feet high and containing a total of approximately 500,000 pounds of gel. The gel used is a special form of silica gel supplied by The Davison Chemical Corporation of Baltimore, and developed by them in cooperation with Sun's research staff over the past several years.

Each silica gel case will go through 15 cycles per day or one about every 100 minutes. The cycles are staggered, like a six-cylinder engine, so as to provide substantially continuous operation in so far as the balance of the plant is concerned.

A gel life of one year is predicted from pilot plant life studies. The gel will be protected from moisture and other poisons by regenerative, pretreatment driers on each of the three streams feeding the cases. At the end of its life the gel will be discarded and

Figure 3. Refractive Index of Case Effluent During Progression Through One Cycle.



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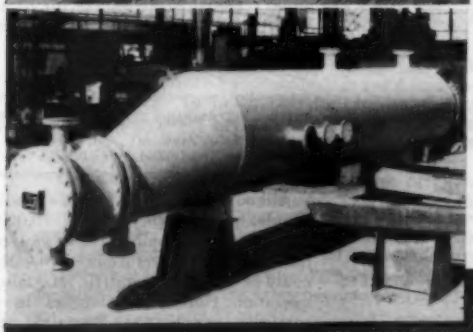

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replaced with fresh material. Replacement of gel can be accomplished in one case at a time thus not destroying continuity of operation. Under all circumstances the recovery of available aromatics is high, but it is diminished somewhat as shown in Table 1 at very high levels of aromatic purity:

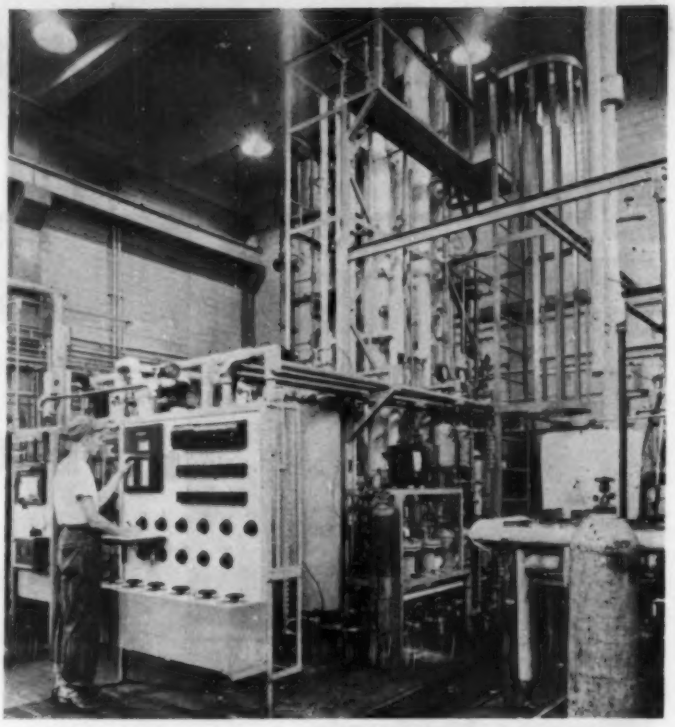
TABLE 1

Percent Purity	Percent Recovery
98	90
96	94
94	96
90	98

No problem is experienced in making specification benzene and toluene other than that a light sulfuric acid treatment is usually required to meet the acid wash specification. Not much acid is required as olefins, which cause off-test acid wash, are largely rejected to the saturate product in the Arosorb Process.

The cyclic operation of the gel cases is automatically controlled. A meter in the effluent line from each case maintains the flow rate constant at any desired level. This permits the quantity of charge and of desorbents *A* and *B* to be controlled wholly by a cycle timer which also keeps the operation of the six cases staggered.

The effluent is accurately and automatically cut from the saturate to the aromatic product line by an instrument developed in Sun Oil Company laboratories. This instrument measures an appropriate property (such as refractive index) of the effluent and is adjusted to switch the product valves at predetermined times after this measured characteristic of the effluent passes through a minimum, see Figure 3.



Arosorb Pilot Plant Unit at Marcus Hook, Pa. (Courtesy, Sun Oil Company.)

Investment and operating costs of an Arosorber vary with the size of the unit, the desired purity of the product, the aromatic content of the feed, the way the plant is integrated with other facilities, and other factors. However, Table 2 gives typical figures which include reasonable allowances for overhead, taxes, maintenance, ten-year depreciation, etc.

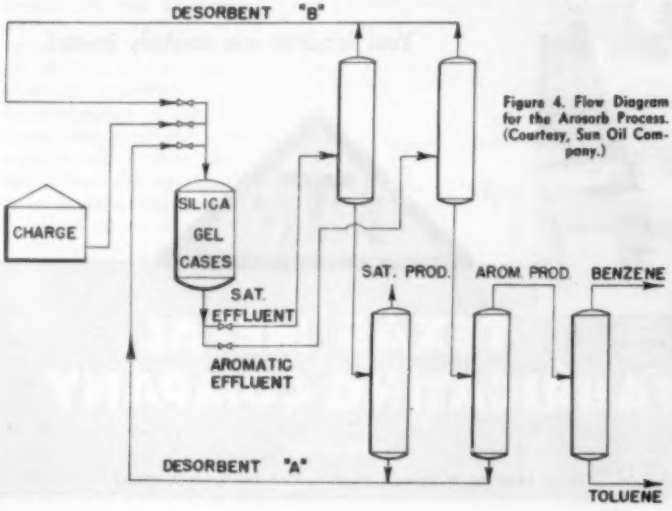


Figure 4. Flow Diagram for the Arosorb Process. (Courtesy, Sun Oil Company.)

TABLE 2

Capacity, B/D Aromatics	1,000	2,000
Investment Cost	$1,200,000	$1,900,000
Oper. Cost, c/Gal. Aromatics	6½	5

Although Sun Oil Company will couple its Arosorber with a 10,000-barrel-per-day Houdriformer, any of the new catalytic reforming processes could be used. The catalytic reforming operation converts naphthenes in a carefully fractionated straight-run gasoline into aromatics. Suitable redistillation of the product is used to prepare aromatic rich feed for the Arosorber. Final fractionation of the aromatic product then produces specification products.

Costs and steel requirements compare favorably with competitive processes on a per-barrel-of-product basis.

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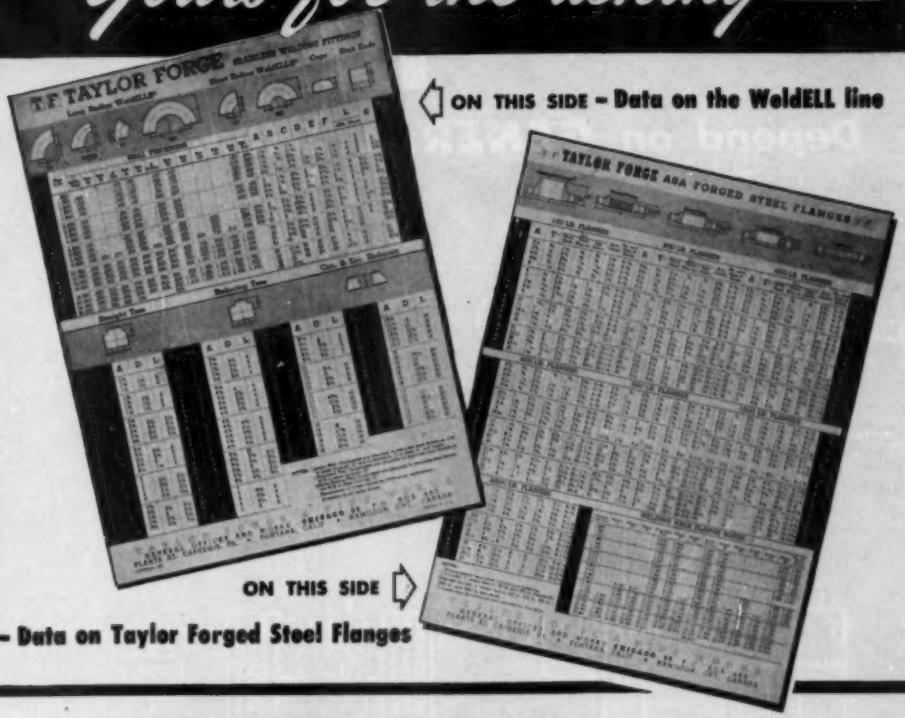
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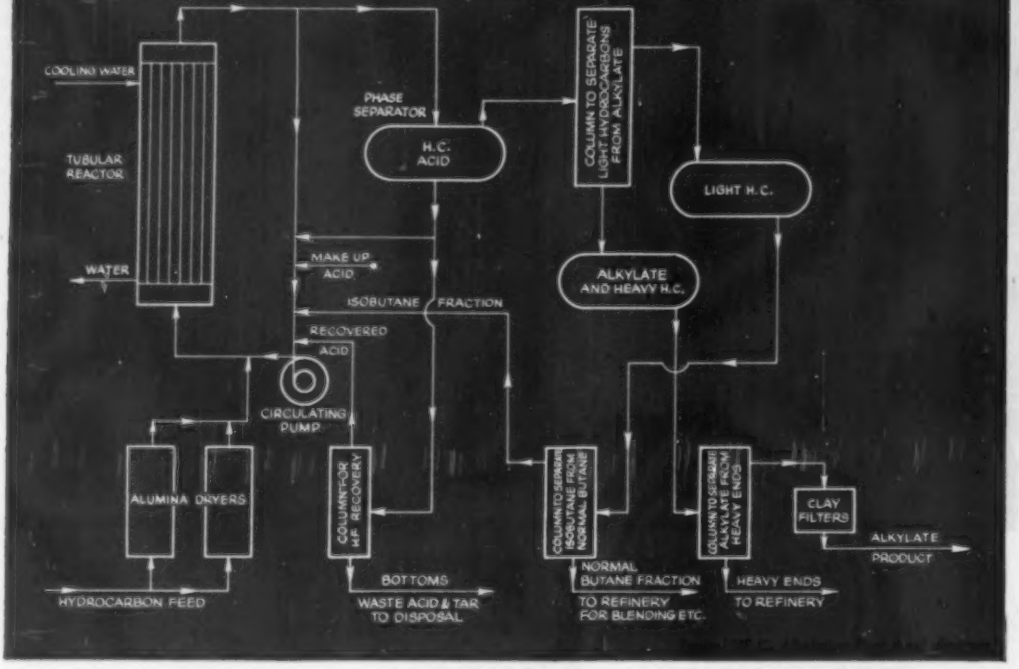

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Shell BENZENE Recovery Process

Shell Development Company, Emeryville, Calif.

IN THE Shell benzene recovery process, benzene is separated from non-aromatics by extractive distillation. The extractive solvent is a relatively high-boiling liquid which has selective solvency for the aromatic and thus decreases its volatility relative to the non-aromatics. In the presence of such a solvent, the customary constant-boiling mixtures are absent, and non-aromatics normally boiling 25° F. above the aromatic can be distilled overhead.

The solvent usually used in this process is phenol, but in special cases other solvents such as cresylic acids or sulfolanes may be preferable. The main steps in the process are:

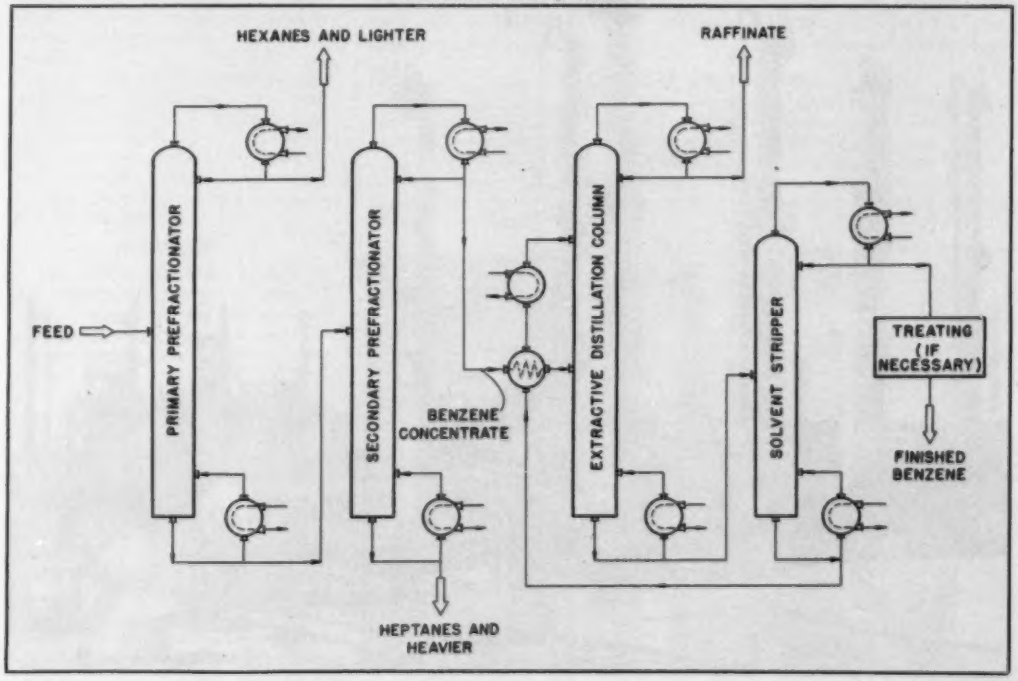
1) Prefractionation
2) Separation of benzene by extractive distillation
3) Acid treating and redistillation

The original charging stock is first fractionated to prepare a benzene concentrate. To obtain sharp separation, the two prefraction columns normally have from 50 to 65 trays each. Since all low boiling material can be separated from benzene during extractive distillation, the removal of light components by the first fractionator serves primarily to lighten the load in improve operation of the extraction column. Benzene concentrate is the overhead product from the second column.

The extractive distillation column consists of a knock-back section and an extraction section. The benzene concentrate is charged at a point near the middle of the extraction section, and as in ordinary fractionation, vaporization heat is supplied in a reboiler, and the overhead vapors after condensation are partially returned as reflux to the column. The extractive distillation is normally carried out in a column of 65 trays; approximately 25 of these are in the knock-back section which prevents loss of solvent in the overhead raffinate. The top product contains essentially all the non-aromatics including the olefins and diolefins and only a trace of solvent. The bottom product is a mixture of benzene and solvent; the constituents are separated in the solvent stripping column, which has 30 trays. Benzene is distilled off as top product, and the solvent is recycled to the extractive distillation column.

The loss of benzene in the raffinate from the extractive distillation column is primarily a matter of control but need not exceed one percent of the raffinate stream. Loss of solvent other than by mechanical leakage result

Shell Benzene Recovery Process



from incomplete fractionation of solvent from the raffinate in the extractive distillation column and from benzene in the stripping column. If the solvent losses should become excessive, the solvent (phenol) can be recovered by caustic washing followed by neutralization with sulfuric acid and distillation. These facilities usually are not required and are not included in the flow sketch. When processing stocks containing diolefins, solvent may be lost also by reaction between the solvent and diolefins.

With appropriate design of the prefractionating columns the feed stock may be any ordinary hydrocarbon mixture with sufficient benzene to give a concentrate containing about 10 percent or more benzene. If the feed contains significant amounts of reactive materials such as mercaptans or diolefins, these must be removed from the feed or from the concentrate.

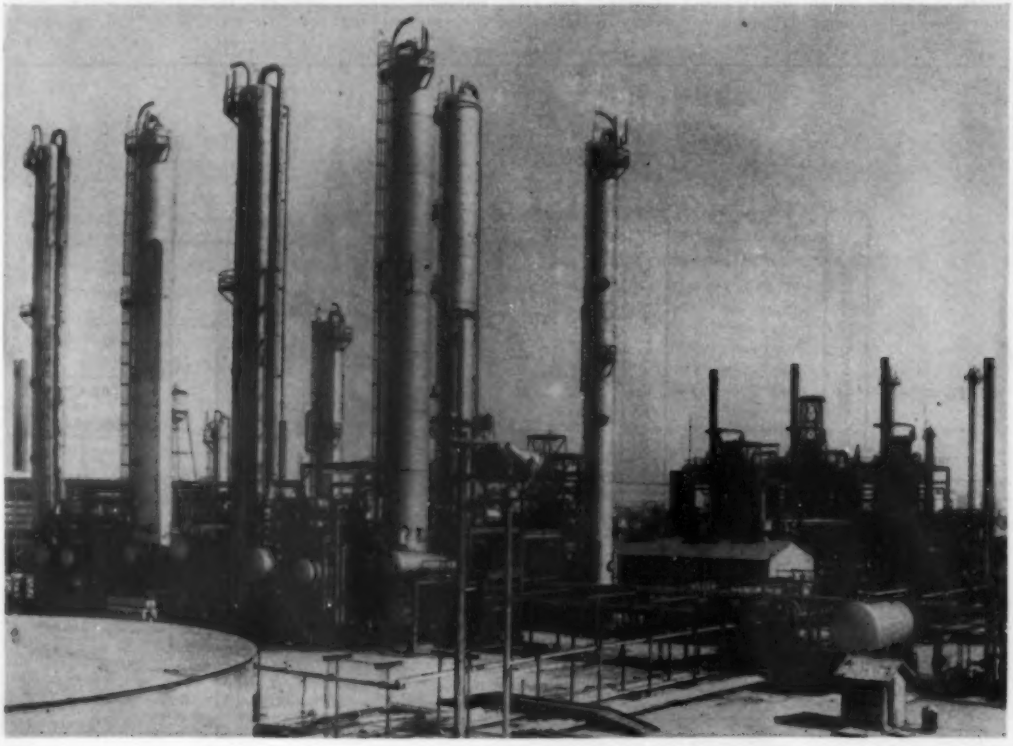
In commercial operation the recovery of benzene from suitable feed stocks is better than 90 percent. The product has a purity of 98 to 99 percent and is satisfactory for most uses; however, acid treating and redistillation may be necessary to meet nitration specifications.

BENZENE consumption in 1950 totaled 188 million gallons for the production of styrene, phenol, nylon, aniline, synthetic detergents, and other uses. The great majority of this benzene was derived from coking operations, which are directly connected with steel production. As a result of planned expansions in styrene, phenol, and other chemicals made from benzene, it has been predicted that the demand for this aromatic will be 30 percent greater in 1951, and will increase even further with each succeeding year. On the other hand, the rise in demand for steel has been less than one-fourth as great as the increase in chemical grade benzene requirements. Hence it is apparent that more and more benzene must come from new sources, of which petroleum is a proven possibility.

Benzene does not occur in petroleum to any appreciable extent, but it can be synthesized by reforming petroleum components such as methylcyclopentane, and cyclohexane. The separation of benzene from the conversion effluent is greatly complicated by the constant-boiling mixtures formed, and the production of high-purity benzene by ordinary distillation is not possible. However, it is possible, by special techniques, to produce high-purity benzene from petroleum. Shell Oil Company has been manufacturing benzene from petroleum at their Wilmington refinery since early 1950. The process, herein described, is based on extractive distillation using solvents such as phenol, cresylic acids, or sulfolanes.

In essence this process is also applicable to the recovery of toluene and xylenes from corresponding aromatic-non-aromatic stocks.

Benzene Recovery Plant of Shell Oil Company, Wilmington, Calif.



THE GIRDLER CORPORATION

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THE GIRBOTOL PROCESS

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SULPHUR RECOVERY

Girdler sulphur recovery plants convert hydrogen sulphide to elemental sulphur. The basic process material—hydrogen sulphide—can be removed easily from sour refinery gas, natural gas, or liquid hydrocarbons by a Girdler Girbotol plant. Sulphur recovery is a practical solution to the problem of disposal of hydrogen sulphide. It also produces a profitable product, now in particularly high demand, from a waste material.

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HYDROGEN

The Girdler HYGIRTOL Plant produces high-purity hydrogen at a remarkably low cost. By reacting hydrocarbons with steam over suitable catalysts at elevated temperatures, the hydrocarbons are converted to carbon oxides and hydrogen. Carbon monoxide is then reacted catalytically with steam to produce hydrogen and additional carbon dioxide. The carbon dioxide is removed by the Girbotol process. With successive purification steps, hydrogen of extremely high purity (99.8%) can be obtained.

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Girdler designed plants for the production of anhydrous and aqueous HCl are based on a commercially proven process with direct reaction between H_2 and Cl_2. The H_2 may be made from natural gas or propane in a Girdler HYGIRTOL plant.

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Girdler plants are designed and built to manufacture high-purity synthesis gas needed for the production of ammonia, methanol, and other chemicals. These plants include all the modern features that characterize Girdler's gas production units and gas purification processes.

AMMONIA SYNTHESIS

Girdler designs and builds plants for the production of synthetic ammonia employing Girdler's synthesis gas manufacturing process combined with the highly efficient L'Air Liquide Ammonia synthesis process.

CARBON MONOXIDE

High purity carbon monoxide can be produced from hydrocarbons by producing a gas rich in carbon monoxide by catalytic reforming process and through low temperature separation recover the pure carbon monoxide.

CATALYSTS

Girdler manufactures catalysts of recognized superiority. Types produced include desulphurization catalysts for conversion of carbon oxysulphide, carbon disulphide, mercaptans, and thiophene to hydrogen sulphide; catalysts for the removal of oxgen or hydrogen from gas streams; noncoking reforming catalysts for use in manufacture of hydrogen. Girdler also makes catalysts according to customer specification or formulae.

Catalysts are manufactured as impregnated materials or as lumps or irregular shapes in any specified size. Density, weight, and preshrinking can be controlled within definite limits. All work is under the direction of expert technicians. Girdler's research personnel is eminently qualified to handle special investigations for catalyst customers.

CARBON DIOXIDE

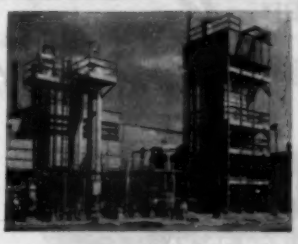
Many types and sizes of commercial carbon dioxide plants are designed and built by Girdler. Production of commercial quantities may begin with gas, oil, gas mixtures, coke or coal as fuel. Carbon dioxide may be delivered as palatable gas or liquid, or in solid form as dry ice.

Small, self-contained plants that use oil or gas as fuel are available in two standard models. They have rated capacities of 150 and 300 pounds of gaseous or liquid carbon dioxide per hour.

GET GIRDLER ON THE JOB

Girdler designs and builds many different types of plants for the refining and chemical industries—has developed a number of widely used chemical processes—is licensing agent for several additional processes. Recovery, purification and use of by-product gases is a specialty. Girdler's research department can conduct laboratory and pilot plant tests of processes in preliminary stages of development. Data they secure will be translated to design details for your final plans. Consult with Girdler on your chemical processing problems.

HYGIRTOL—is a trade mark of The Girdler Corporation



Left: A portion of Girdler's well equipped catalyst plant where high quality catalysts can be produced according to customer specifications.

Below left: A Hygirtol plant for producing high-purity hydrogen from hydrocarbons and steam.

Below: An installation for the removal of hydrogen sulfide from natural gas by Girbotol Process. Similar plants are extensively used for removing hydrogen sulfide from refinery gases and liquids and for the removal and recovery of carbon dioxide.

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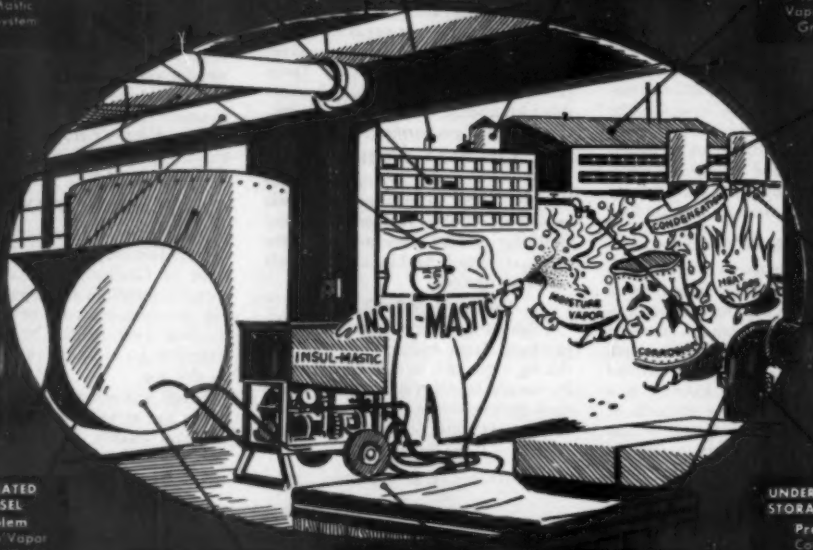

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Modified EDELEANU Process For Recovery of Aromatics

Stone & Webster Engineering Corporation,
Badger Process Division, New York

THE process described herein is a modification of the SO_2 extraction process invented in the early part of this century by L. Edeleanu, a Roumanian petroleum engineer. The Edeleanu process uses liquid sulfur dioxide for the selective extraction of aromatic hydrocarbons from petroleum fractions. It is widely used for the removal of such hydrocarbons from naphtha, kerosine, gas oil and lubricating oil. In its normal application the original Edeleanu process serves to produce refined oils of essentially paraffinic and naphthenic character, although very often, and especially with the treatment of naphthas, the aromatic extract is a product equal in value to the paraffinic raffinate.

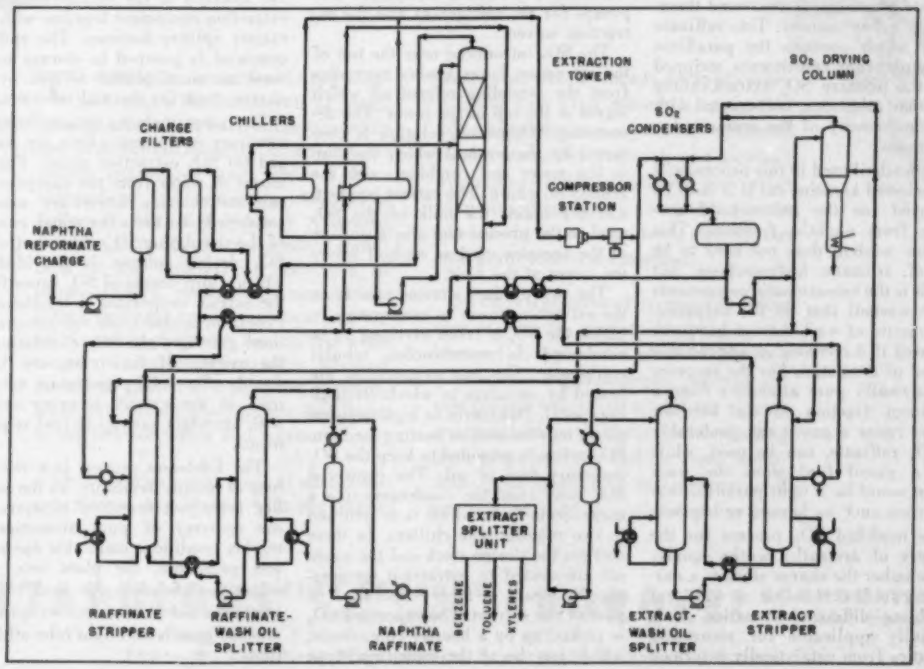
The extracts obtained by the straight SO_2 treatment of stocks containing benzene, toluene and xylenes at contacting temperatures of about 0 to 10° F. will contain these aromatics at a concentration of 60 to 70 volume percent. With the treatment of kerosine extracts containing 75 to 80 percent of aromatics have been produced in commercial operation, and the extracts from gas oils are still more concentrated. To increase the purity of the aromatics recovered from naphtha fractions one refiner has operated the

THE EDELEANU process based on SO_2 extraction has been used commercially since 1911 for refining petroleum products. Up until World War II the process was used chiefly to produce essentially paraffinic and naphthenic products, such as naphthas, kerosines, and oils, by removing the aromatic constituents.

During the war the process was extended to the production of badly needed toluene. This toluene was produced in nitration quality from Hydroformate. However, it was not possible heretofore to produce high purity benzene because of the problems of separating the close-boiling impurities.

This modification of the original Edeleanu process makes it possible to concentrate an SO_2 extract to the complete exclusion of paraffinic and naphthenic hydrocarbons. By this method it is then possible to separate from a suitable reformate high purity benzene, as well as toluene and concentrated xylenes.

Figure 1. Schematic Flow Diagram of Modified Edeleanu Process for Aromatics Recovery. (Courtesy, Stone & Webster Engineering Corporation, Badger Process Division.)



SO_2 process at the temperature of —60° F. The naphtha extracts produced at that temperature level contain aromatics in an overall concentration of close to 85 percent, and selected fractions from these extracts will contain up to 93 percent of aromatics. For the recovery of aromatics at essentially 100 percent purity, such as nitration-grade benzene or toluene, the straight SO_2 extraction process must be supplemented by an extract stripping step.

This modification of the original Edeleanu process, which was developed in the early thirties, makes it possible to further concentrate an SO_2 extract to the complete exclusion of paraffinic and naphthenic hydrocarbons. In this process, which provided a large share of the nitration-grade toluene required during World War II, the just mentioned non-aromatic hydrocarbons are stripped from an SO_2 extract by means of displacement with a paraffinic or naphthenic hydrocarbon fraction of different boiling range, which is called wash solvent. This stripping is done in presence of SO_2 in a tower extractor at temperatures ranging from 0 to —20° F. Part of the wash solvent will remain in solution in the extract product, and is removed therefrom by simple distillation after the SO_2 has been recovered. The balance of the washoil goes into the raffinate phase and is recovered therefrom in a like manner. This raffinate phase, which contains the paraffinic and naphthenic constituents stripped from the primary SO_2 extract, along with some aromatics, is re-treated with SO_2 for recovery of the aromatic hydrocarbons.

The washoil used in this process will be a selected kerosine cut if it is to be employed for the recovery of aromatics from naphtha fractions. This kerosine washoil does not need to be free of aromatic hydrocarbons, but since it is the non-aromatic components in the washoil that do the stripping, the quantity of wash solvent has to be increased if it contains an appreciable amount of aromatics. For the recovery of practically pure aromatics from a petroleum fraction in the kerosine boiling range a gasoil cut, preferably an SO_2 raffinate, can be used, while with a gasoil feed stock the wash solvent could be a light paraffinic hydrocarbon such as hexane or heptane.

The modified SO_2 process for the recovery of aromatics works equally well whether the charge stock is a narrowly cut fraction or a wide cut containing different aromatics. It is especially applicable for recovering aromatics from catalytically reformed stock. The purity of the recovered aromatics is independent of their concentration in the charge to the SO_2 plant, but the over-all recovery is, of course, higher with high initial concentrations. The process is only mildly selective as to olefins, and if nitration-grade products are to be made the extract product must be given an acid treatment or some other treatment suitable for olefin removal. The washoil used in the stripping operation is recovered in the process and recycled for re-use.

The attached schematic flow diagram illustrates the modified Edeleanu process as used for the recovery of aromatics from a naphtha reformate.

The plant comprises the following sections:

SO_2 Extraction and Extract Washing
Charge and Solvent Cooling System
SO_2 Recovery
Washoil Recovery
Auxiliary Equipment

In the plant illustrated a single extraction tower is used for both the SO_2 extraction and the stripping of the extract. In this tower the reformate charge stock is introduced near the middle, the SO_2 at the top and the paraffinic kerosine washoil at the base. All streams charged to the extractor are cooled by heat exchange and refrigeration. SO_2 is employed as refrigerant to permit the use of common condensers, collecting equipment and pumps for the refrigerant and the extraction solvent.

The SO_2 introduced near the top of the extraction tower washes aromatics from the ascending refined oil which leaves at the top of the tower. The descending SO_2-extract solution is contacted by the washoil which rises up in the tower and combines with the refined oil phase. The extract product, which contains the bulk of the SO_2 used in the process and also a portion of the kerosine used as washoil leaves the tower at the base.

The two product streams pass from the extraction tower to evaporators in which the SO_2 is taken overhead to be condensed in water-cooled tubular equipment. The two evaporators are heated by reboilers in which circulating gasoil, Dowtherm or high-pressure steam may be used as heating medium. SO_2 reflux is provided to keep the SO_2 inventory free of oil. The recovered SO_2 flows from the condensers into a surge drum from which it is returned to two reboiler-type chillers. In these chillers the charge stock and the washoil are cooled to extraction temperature by means of flash evaporation of part of the solvent. The vaporized SO_2 is picked up by a booster compressor, which may be of the centrifugal type and thence by the main compressors which discharge the vapor to the water-cooled condensers. The self-refrigerated SO_2 solvent is picked up from the chillers and pumped into the extraction tower.

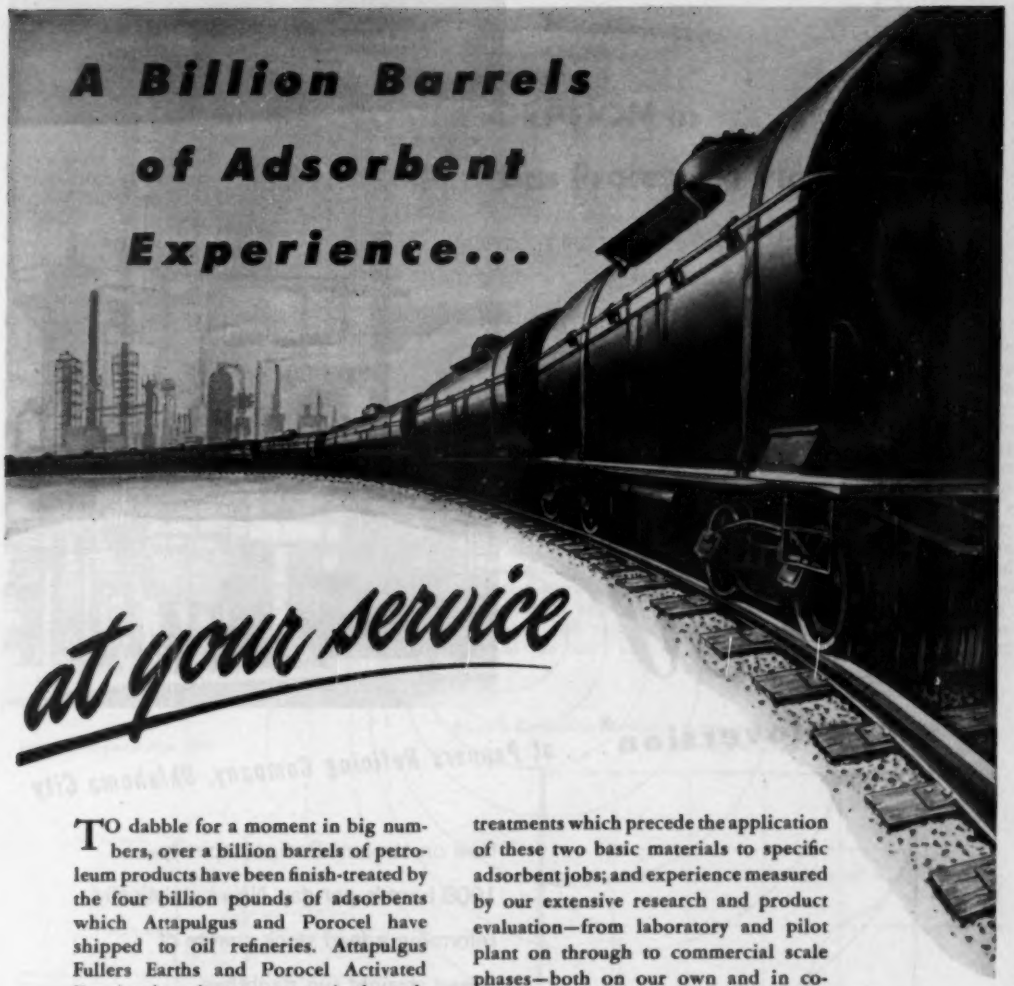
The SO_2-free extract product from the extract evaporator flows under its own pressure into an extract splitter, in which the aromatic product is taken overhead and the kerosine washoil is the bottoms product. The overhead is condensed and fractionated. In the plant shown the reformate charge stock is assumed to contain benzene, toluene and xylenes. These aromatics are separated in suitable fractionators. If the complete removal of olefins from the product is important, the extract may be acid-treated ahead of the benzene column. The xylene bottoms from the toluene column would then be rerun.

The washoil removed from the extract product in the extract-washoil splitter is picked up from the base of that tower and returned to the extractor through a heat exchanger and the SO_2-cooled chiller.

The aliphatic raffinate is freed of SO_2 in its stripper, the operation of which is identical with that of the extract stripper. The raffinate product is passed to the raffinate-washoil splitter, from which the washoil bottoms are returned to the refrigeration and extraction equipment together with the extract splitter bottoms. The splitter overhead is pumped to storage to be used as an aliphatic solvent or as charge stock for thermal reforming.

The plant includes certain items of auxiliary equipment which are standard for SO_2 extraction plants. For removal of water from the charge stock calcium chloride filters are usually employed. To keep the water content of the circulating SO_2 under control an SO_2 drying column is provided in which a slip stream of SO_2 vapor from the extract evaporator is fractionated. Provision is also made for removal of inert gas from the SO_2 circulating in the system. If fuel costs are high, double effect SO_2 evaporation may be used in the extract recovery system with attendant savings in fuel requirements.

The Edeleanu process is a refining tool of unique flexibility. In the modified form just described it serves for the recovery of pure aromatics. If market conditions make this operation less profitable, the plant can, with minor modifications, be used for the treatment of kerosines, virgin or cracked gasoils and light lube oil fractions.



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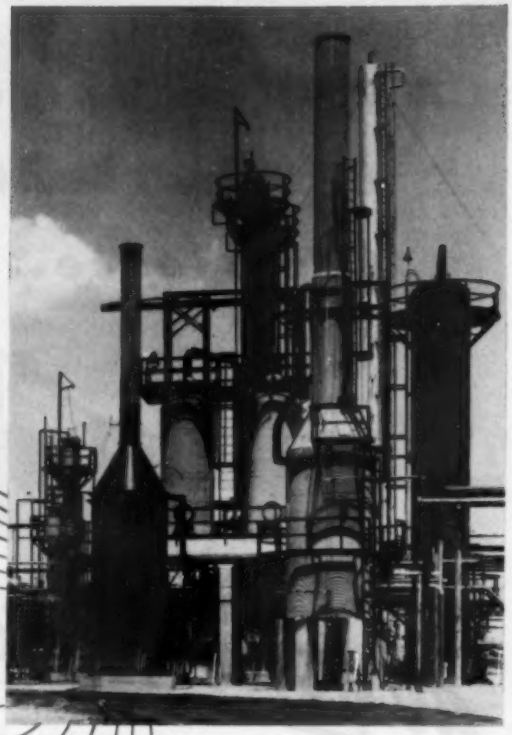

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HYPERSORPTION INSTALLATIONS

The Hypersorption Process for separation of gases by adsorption is finding further applications as a processing tool. Installation of Hypersorption units now includes the following locations:

The Dow Chemical Company, Midland, Michigan.

Rohm and Haas Company, Houston, Texas.

American Cyanamid Company, Azusa, California.

Standard Oil Company of California, Richmond, California.

The Dow Chemical Company, Midland, Michigan.

The Dow Chemical Company of Canada, Sarnia, Ontario.

HYPERSORPTION in Modern Gas Processing Plants

CLYDE BERG, Union Oil Company of California, Wilmington, Calif.

PROCESSING companies are increasing their use of Hypersorption as a tool for separation of volatile hydrocarbons and other gases in chemical refining and natural gas operations. The largest unit built to date will go on stream shortly at Midland, Mich., in the plant of The Dow Chemical Company. The process has completed more than four years of successful commercial operation and units with capacities ranging up to 16 million cubic feet per day are in operation.

A diagram of a Hypersorption unit of modern design is presented in Figure 1. It will be noted that in external appearance this unit resembles a single, tall fractionating tower, its principle distinctive feature being that of the lift line which is attached to the side of the tower and which effects circulation of the solid within the tower by transport as a suspension in a dilute gas stream. The processing conditions indicated on this diagram are typical of a unit recovering ethylene from a gas produced by high-temperature cracking. The cutaway section of the diagram reveals the fact that the tower has two heat exchange sections, a cooler at the top and a Dowtherm-heated stripper exchanger at the bottom. Between the cooler and stripper there are four trays. The feed is introduced through a distribution tray, passes countercurrent to the moving activated carbon and is disengaged as lean overhead product

Figure 1. Hypersorption Unit.

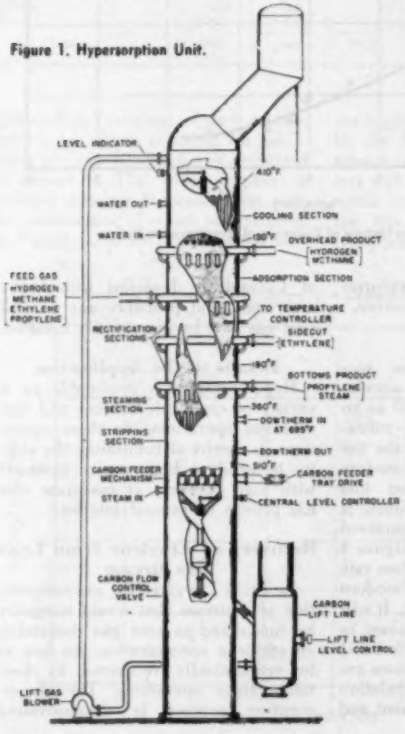
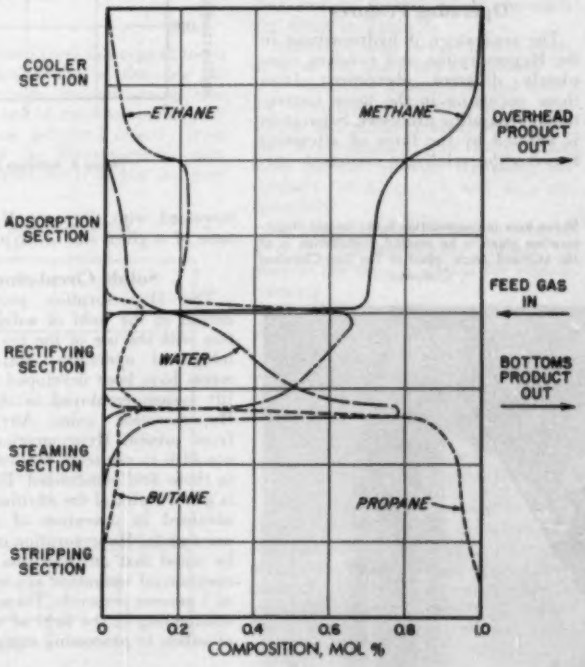


Figure 2. Composition Distribution in Hypersorber Separating Propane and Heavier from Natural Gas.



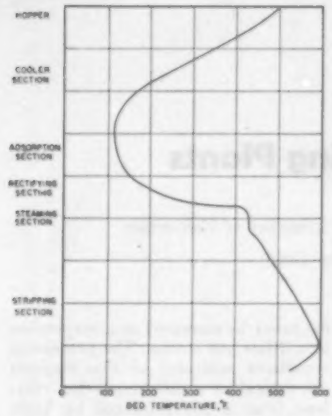


Figure 3. Temperature Distribution in Hypersorber Separating Propane and Heavier from Natural Gas.

through a tray immediately below the cooling section at the top of the unit. The adsorbed material is produced as two streams; the disengaging tray immediately below the feed point releases the intermediate ethylene product, whereas the disengaging tray near the bottom of the unit just above the stripping section disengages propylene and steam.

Operating Features

The separation of hydrocarbons in the Hypersorption unit involves completely different phenomena from those occurring in the more conventional separating processes. Separation is effected by the force of attraction between the relatively enormous surface area of activated carbon and the molecules of the gas stream being contacted. A plot of the charge in composition from top to bottom of a Hypersorption unit carrying out the recovery of propane and heavier from a natural gas stream is given in Figure 2. The temperature effects accompanying this separation are given in Figure 3.

Stripping and liberation of absorbed compounds in the Hypersorption operation is effected by a means quite unlike that in conventional processes. The high retentive power of activated carbon is almost completely released in the desorption zone and stripping is effected with ease under a variety of operating conditions. Improvements in the method of introducing steam and carrying out stripping in the modern Hypersorption unit have appreciably increased with the over-all performance of a given size of Hypersorber.

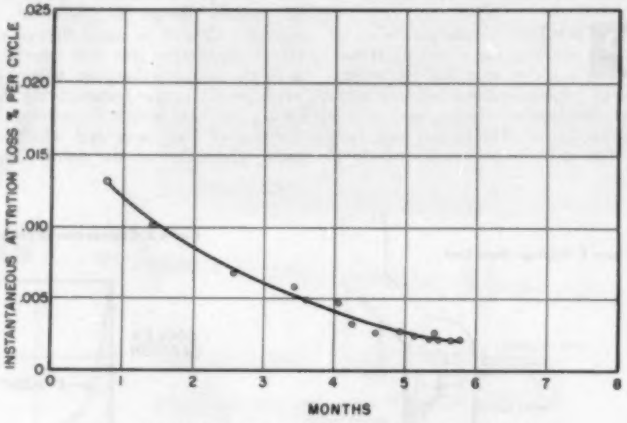


Figure 4. Attrition Loss History of Commercial Hypersorption Unit.

Shown here in construction is the largest Hypersorption plant to be erected. Installation is at the Midland, Mich., plant of The Dow Chemical Company.

Solids Circulation

The Hypersorption process pioneered in the field of solids circulation with the use of the gas lift as an integrated operation. Major refinements have been developed in the gas lift system employed in the modern Hypersorption units. Attrition loss from present Hypersorption units is one-fifth to one-tenth that encountered in those first constructed. In Figure 4 is given a plot of the attrition loss rate obtained in operation of a modern commercial Hypersorption unit. It will be noted that attrition loss values in commercial operation approach 0.001 of 1 percent per cycle. These losses are outstanding in the field of circulation of solids in processing equipment and reflect the high degree of refinement obtained in the design of the gas lift system.

The activated carbon charge of a Hypersorption unit is normally maintained at a relatively high level of activity by reactivation to compensate for whatever accumulations of adsorption oil and polymers of heavy di-olefins that may deposit on the carbon. In Figure 5 is given a plot of the activity of the charge of a commercial Hypersorption unit for reactivation operations. Generally speaking virtually any feed gas can be handled in a Hypersorption unit provided adequate reactivation facilities are designed and put into operation. Adequate activity has been maintained in pilot plant operations employing gas from high-temperature gas-oil cracking containing substantial quantities of C_4 and C_5 di-olefins with heavy acetylenes, and probably any normal feed gas will be more easily handled.

Details of the Application

Hypersorption is applicable to a variety of chemical, refining and natural gas operations. In these operations its merits of combining the ability to produce high purity products with high recovery at moderate cost has proven of general interest.

Recovery of Ethylene from Lean Gas Stream

In Table 1 is given the gas composition of a stream that would normally be considered as vent gas containing an ethylene concentration too low to be economically recovered by low-temperature operations. The Hypersorption process is demonstrating

commercially a 98 percent recovery of the ethylene content of this stream.

The product gas stream, listed as "make gas" in the table, is free of contamination of methane within the limits of the analytical tests. This remarkable separation of key components in the relatively short adsorption and rectifying bed of this commercially operating Hypersorption unit is unique among separation processes. In Figure 6 is given the process flow sheet of this Hypersorption plant and construction of the Hypersorber is detailed in Figure 7.

Production of Ethylene from Refinery Gases

One of the more valuable applications of Hypersorption is in the processing of refinery gas streams to produce ethylene and recover propane and ethane. The flow sheet of such a plant employing ethane cracking for maximum ethylene production is presented in Figure 8. This plant employs a rectified side cut Hypersorption unit, the construction of which is illustrated in Figure 9. A well-fractionated side cut is produced from this type of tower by the fractionation of the side cut stream through countercurrent contact with a bed of uncontaminated activated carbon delivered directly from the top of the Hypersorption unit. Components of the feed gas and product streams for this plant operation are given in Table 2.

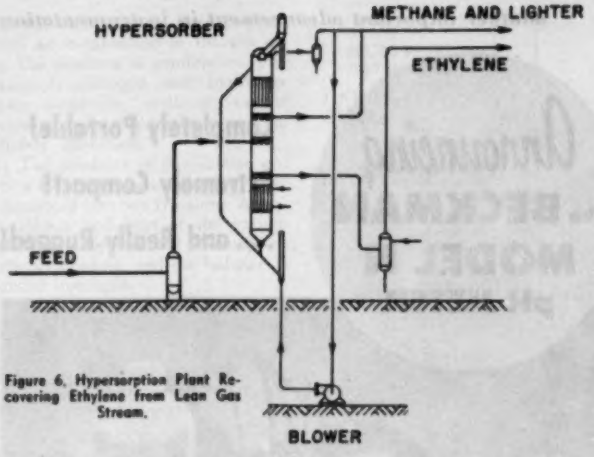


Figure 6. Hypersorption Plant Recovering Ethylene from Lean Gas Stream.

TABLE 1

Application of Hypersorption to the Recovery of Ethylene From a Lean Gas Stream

Composition	Feed Gas, Mol. %	Bottoms Product, Mol. %	Overhead Product, Mol. %	Purge Gas, Mol. %
Hydrogen	30.8	....	31.6	61.8
Nitrogen	1.7	....	1.4	2.5
Carbon Monoxide	0.9	....	0.8	1.3
Oxygen	0.1	0.1	0.1	0.2
Methane	51.3	....	65.1	33.7
Carbon Dioxide	0.2	2.9	....	0.1
Acetylene	0.2	3.6	....	....
Ethylene	5.8	92.7	....	0.4
Ethane	Trace	0.7	....	....
Total	100.0	100.0	100.0	100.0

TABLE 2

Application of Hypersorption to the Recovery of Ethylene From a Refinery Gas Stream

Composition	Ref. Gas Mol. %	Hyper. Feed Mol. %	Overhead Product, Mol. %	Bottoms Product, Mol. %	Hyper. Side Cut Mol. %	Ethyl Frect Overhead Mol. %
Hydrogen	2.22	11.91	25.40	....	....	....
Methane	31.55	38.46	72.92	....	0.84	1.36
Ethylene	3.92	13.24	0.35	1.79	39.32	97.11
Ethane	22.56	25.16	0.33	3.44	59.84	1.54
Propylene	61.8	4.62	....	29.35	0.16	....
Propane	11.94	8.22	....	54.20	0.14	....
C_4's+	1.60	1.47	....	11.12	....	....

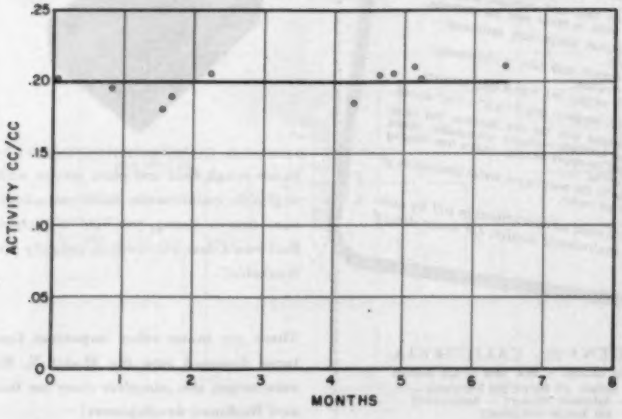
Important steps in the cycle of operation of this plant are as follows:

1) Recovery of ethylene and heavier components from refinery gas stream and ethane cracker effluent in the Hypersorption unit to produce three product streams consisting essentially of C_1's, C_2's and C_3's respectively.

2) Separation of ethane-ethylene in a small low-temperature column to provide the recycle stream for ethane cracking.

3) Production of the C_3 fraction directly for use as fuel in other chemical processing operations. This fraction can be cracked for a maximum over-all production of ethylene if desired.

Figure 5. Carbon Activity History of a Commercial Hypersorption Unit.



Recovery of Acetylene from Air Oxidation of Natural Gas

The Hypersorption process is valuable in the processing of dilute gas streams for recovery and purification of acetylene. Figure 10 presents a flow sheet of a Hypersorption unit recovering acetylene from gases produced in the air oxidation of natural gas. General steps in operation may be out-

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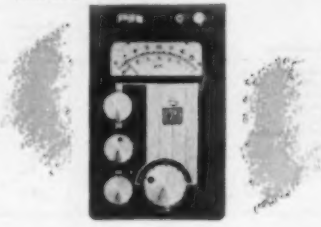

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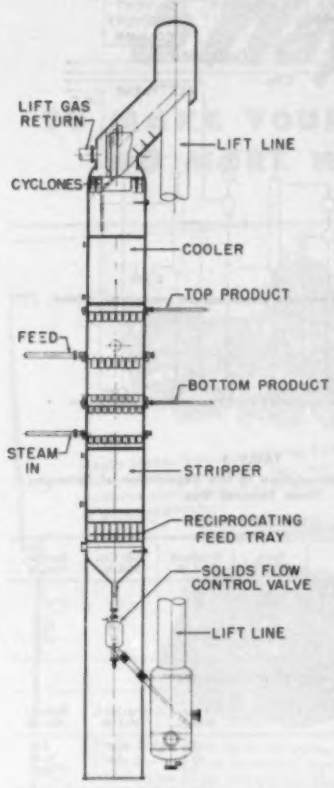


Figure 7. Two-Product Hypersorption Unit.

lined as follows:

1) Air and natural gas are properly preheated and fed to a burner where partial air combustion of the gas occurs. The products of combustion, predominantly nitrogen and hydrogen, carbon monoxide, methane, carbon dioxide, acetylene and ethane, are immediately quenched.

2) The products of combustion are fed to a Hypersorption unit where they are separated into two fractions. Acetylene, ethane and part of the carbon dioxide are adsorbed and produced as a bottoms product, and the balance is produced overhead.

3) The acetylene, ethane, carbon dioxide stream is fed to an absorption-stripping system, and 98 percent pure acetylene is produced overhead from the stripper and ethane-carbon dioxide concentrate released overhead from the absorber.

A general breakdown of stream compositions is given in Table 3.

Separation of Nitrogen from Natural Gas

The Hypersorption process provides a valuable means for separation of nitrogen from low Btu-content natural gas. Simultaneous with the upgrading of the low Btu-content natural gas, recovery of ethane, propane and butane is effected. In Figure 11 is presented a flow sheet for carrying out this operation, and in Table 4 is presented compositions of the streams in this plant.

The sequence of operations may be outlined as follows:

1) The natural gas first enters a three product Hypersorption unit where the methane is taken overhead, ethane as the first side cut, propane as the second side cut, and butane and heavier as the bottoms product.

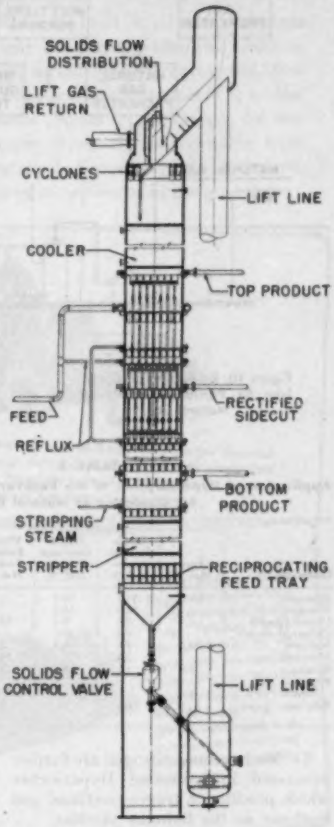
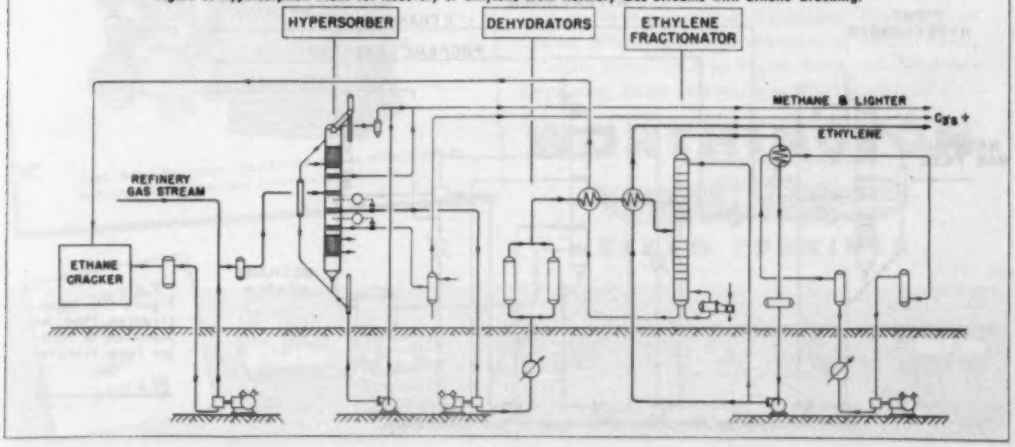


Figure 9. Rectified Side Cut Hypersorption Unit.

Figure 8. Hypersorption Plant for Recovery of Ethylene from Refinery Gas Streams with Ethane Cracking.



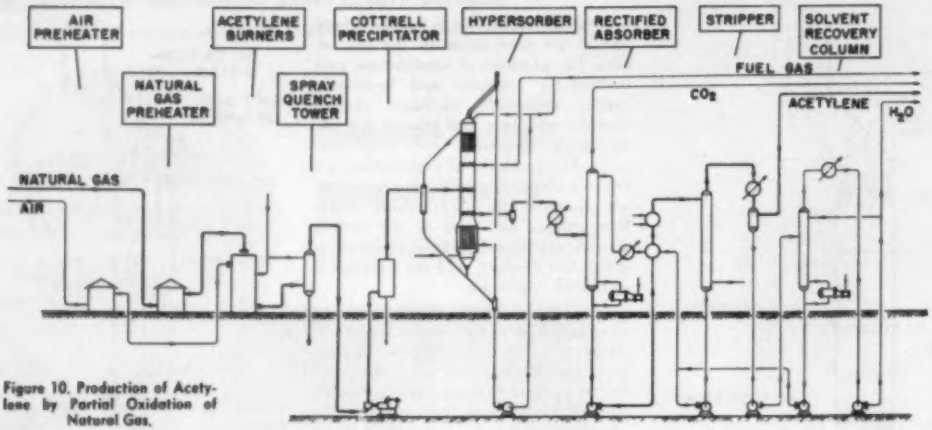


Figure 10. Production of Acetylene by Partial Oxidation of Natural Gas.

TABLE 3

Application of Hypersorption to the Recovery of Acetylene From Air Oxidation of Natural Gas

Composition	Feed Mol. %	Comb. Product, Gases Mol. %	Hyper. Overhead Product Mol. %	Hyper. Bottoms Product Mol. %	Rectified Absorber Overhead Mol. %	Stripper Overhead Mol. %
Hydrogen	....	24.3	25.9	....	....	....
Nitrogen	....	54.5	58.0	....	....	....
Carbon Dioxide	4.3	3.5	2.1	24.6	82.9	2.0
Carbon Monoxide	....	9.4	10.0	....	....	....
Methane	84.3	3.6	3.8	0.3	0.7	....
Acetylene	....	3.5	....	56.0	3.7	98.0
Ethane	6.8	1.0	0.1	15.8	20.3	....
Propylene and Heavier	4.6	....	....	....	....	....
Ethylene	....	0.2	....	3.3	7.4	....

TABLE 4

Application of Hypersorption to the Separation of Nitrogen From Natural Gas

FIRST HYPERSORBER

Composition	Feed, Mol. %	Overhead, Mol. %	Side Cut, Mol. %	Bottoms, Mol. %
N_2	29.6	33.5	....	....
CH_4	56.6	66.3	0.4	....
C_2H_6	6.1	0.2	99.1	0.5
C_3H_8	4.6	....	0.5	80.2
C_4H_{10}+	1.1	....	....	19.3

SECOND HYPERSORBER

Composition	Feed, Mol. %	Overhead, Mol. %	Bottoms, Mol. %
N_2	33.5	99.0	0.8
CH_4	66.3	1.0	98.9
C_2H_6	0.2	....	0.3

2) Methane and nitrogen are further processed in a second Hypersorber which produces nitrogen overhead and methane as the bottoms product.

3) Ethane is re-blended with the methane for pipe line delivery of specification Btu-content gas. Propane and heavier components are delivered as a separate stream for use in LPG and gasoline blending.

ACKNOWLEDGMENT

The author wishes to express his appreciation to Union Oil Company for permission to publish this review of advancements in Hypersorption design.

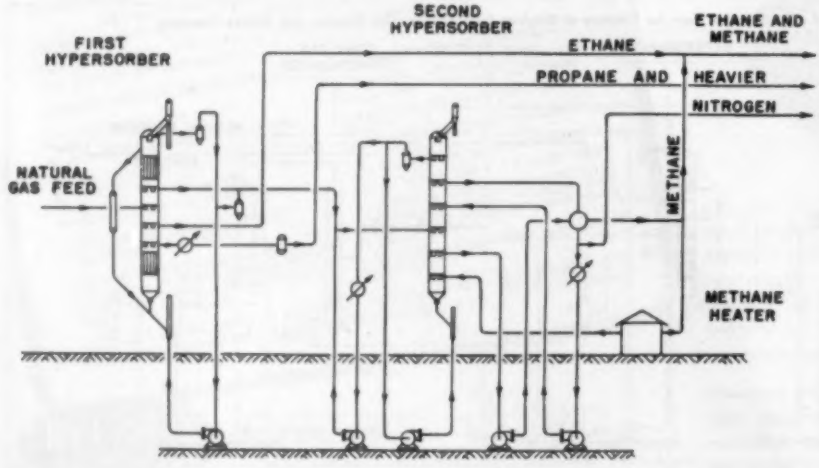


Figure 11. Hypersorption Plant for Separation of Nitrogen from Natural Gas.

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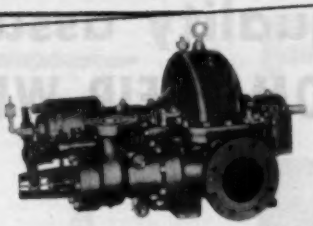

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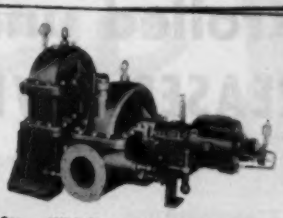

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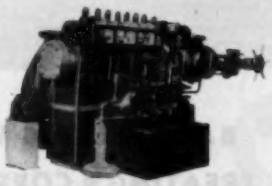

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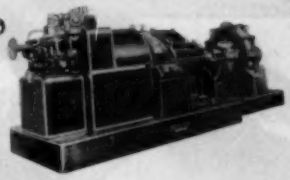

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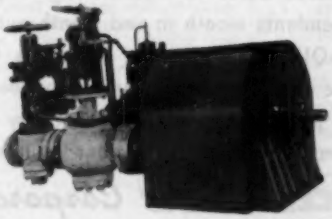

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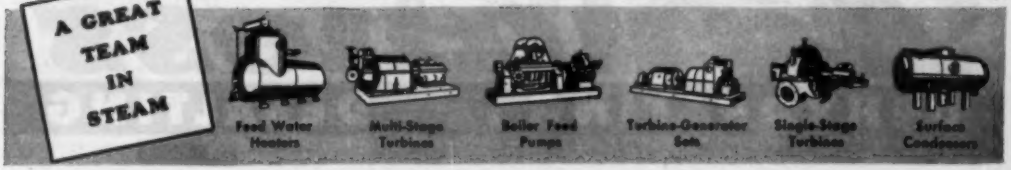

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BOOKS

Organic Chemistry

Textbook of Organic Chemistry, Carl R. Noller, W. B. Saunders Company, West Washington Square, Philadelphia 5, Pa. $5.75.

Because Noller is a professor of chemistry at Stanford University, he aimed his material at the student level. Early chapters introduce the subject matter gradually. No compound is used in the methods of preparation or in the reactions unless its structure has been discussed previously. Discussions of procedures is delayed until the student is familiar with the methods of preparation and with the reactions of alcohols and alkyl halides. Brief descriptions of experiments are given to make the reactions seem more real to the student who has not progressed very far in laboratory work. Practical applications and economic aspects of organic chemistry frequently are discussed in some detail for the benefit of students electing to prepare for industrial positions.

This book is intended for those who desire a text containing an amount of material that can be covered in 90 to 100 lectures.

Piping Information

Industrial Piping, Charles T. Littleton, McGraw-Hill Book Company, 330 West 42nd Street, New York 18. $8.

Littleton formerly was engineer in charge of piping for American Cyanamid Company and he brings together in a single volume a vast store of essential information on industrial piping, to replace the data sheets, leaflets, catalogues, and standard specifications which practicing piping designers, etc., require in their work. It points out what materials and what kind of pipe and fittings should be used, and where. It provides pertinent data on scores of different materials and types of piping required in the chemical, process, and petroleum industries and power plants, to aid in the choice between one material and another.

Each of the most recently developed piping materials, alloys, and plastics used in modern industrial plants is discussed, with its advantages and disadvantages clearly indicated. Of particular value to engineering purchasing departments is the table of valve equivalents for valves in the pressure classes up to 600 pounds.

Separation Processes

A Symposium on Developments in Applied Chemistry. Twenty-fifth Annual Priestly Lectures. Phi Lambda Upsilon and Departments of Chemistry and Chemical Engineering. The Pennsylvania State College, State College, Pa. $2.

Addresses by eminent chemists speaking on the Priestly lecture series have been prepared in reference form and are available for the years 1946, 1948, 1949, 1950 and 1951. The 1951 series marked the twenty-fifth annual Priestly lecture course.

Of special interest to the petroleum industry is an address by Dr. Merrell

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R. Fenske, director of the Petroleum Refining Laboratory of the Pennsylvania State College. Entitled "Physical Separational Processes," the lecture is confined to three processes: distillation, vapor-liquid-extraction, and liquid-liquid extraction. In each case one fluid phase is flowed countercurrently to another fluid phase during which time there is an exchange or transfer of molecules from one phase to another. It is this physical exchange that makes separation possible.

Lubricating Data

Physical Chemistry of Lubricatings Oils, A. Bondi, Reinhold Publishing Corporation, 330 West 42nd Street, New York, $10.

Latest theories on lubricating oils and the physical and chemical principles underlying their action is contained in this volume. It is a broad and well documented treatment of specific problems in lubricant technology. Many inaccessible or widely scattered data and simple methods for the estimation of unknown properties from few given data will prove most valuable to engineers, physical chemists and all technical men in the lubrication field.

Bondi, a member of Shell Development Company at Emeryville, Calif., has been working for many years with practical lubrication problems in the laboratory. He discusses such properties as viscosity, pour point, oiliness, flowing characteristics, foaming, etc., in great detail, and attention is given to additives of all types. One chapter is devoted to synthetic lubricants.

HEI Standards

Heat Exchange Institute Standards for Barometric and Low Level Jet Condensers, Third Edition. Heat Exchange Institute, 122 East 42 Street, New York. $1.

This publication covers such important phases as nomenclature, definitions and standards for condenser performance, and information required in the calculation of water requirements. It also covers vacuum pump capacity, installation, information on atmospheric relief valves and a series of conversion tables, useful in calculation and installation of this type of jet condenser.

Viscosity Measurements

Symposium on Methods of Measuring Viscosity at High Rates of Shear. American Society for Testing Materials, 1916 Race Street, Philadelphia 3. $1.35.

The purpose of this symposium was to find a suitable method for testing viscosity at high rates of shear of various additives used in lubricants and fluids. Interest stemmed from the fact that the use of additives of various types in lubricants and fluids is increasing rapidly and the resultant viscosities of such products may vary with use, in which case, the values obtained in conventional equipment might not indicate their performance in use. Two promising methods were investigated and the results, contained in this report, were presented to the API Committee on Petroleum Products in 1949, and to the Research Di-

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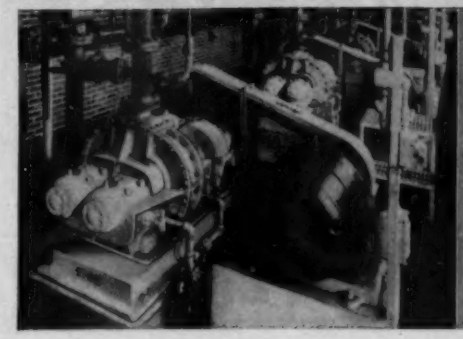

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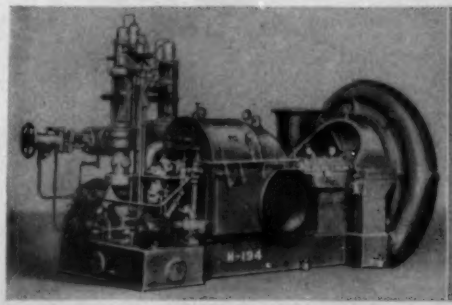

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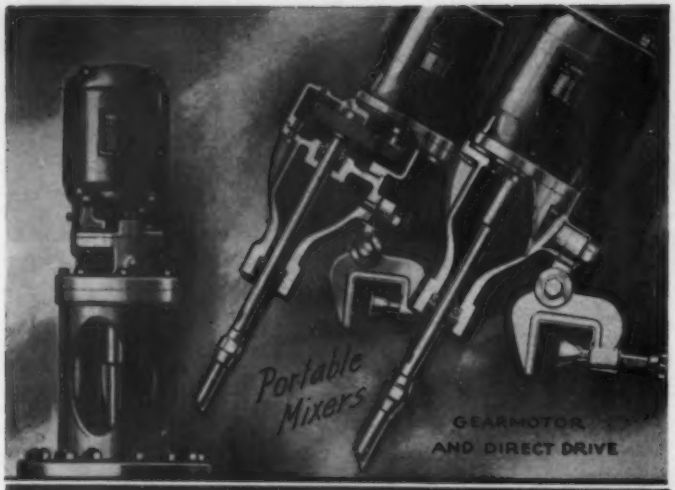

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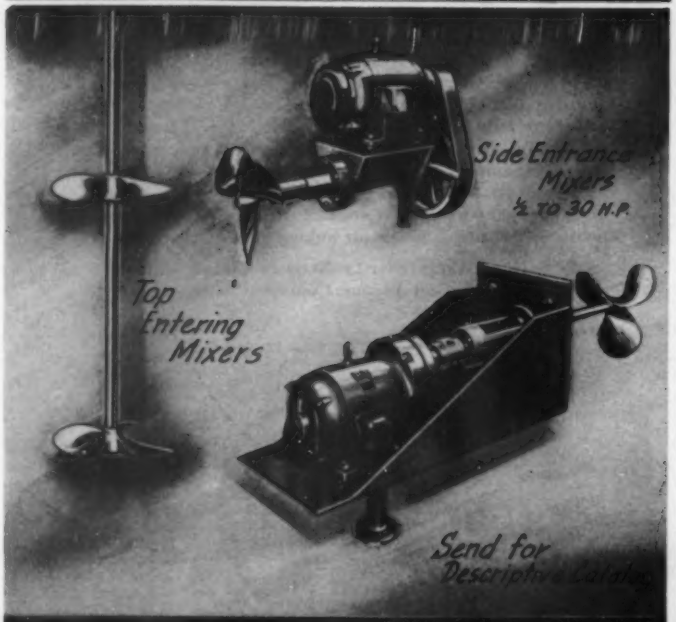

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Books

vision VII on Flow Properties, ASTM Committee D-2 on Petroleum Products and Lubricants, in 1950.

This published symposium contains an introduction by J. C. Geniesse, The Atlantic Refining Company, and the following papers: Viscosity-Shear Behavior of Two Non-Newtonian Polymer-Blended Oils, M. R. Fenske; E. E. Klaus and R. W. Dannenbrink of The Pennsylvania State College; The Kingsbury Tapered-Plug Viscometer for Determining Viscosity Variations With Temperature and Rate of Shear, S. J. Needs, Kingsbury Machine Works, Inc.; The Comparison of Viscosity-Shear Data Obtained with the Kingsbury Tapered Plug Viscometer and the PRL High Shear Capillary Viscometer, Fenske, Klaus and Dennenbrink.

Instrumentation Data

The Handbook of Measurement and Control, Edited by M. F. Behar. The Instruments Publishing Company, Inc., 921 Ridge Avenue, Pittsburgh 12. $3.

This Handbook is designed to bring classifications, operating factors, and typical applications of instruments to users, manufacturers, and students. The term "instruments" includes all indicating, recording, integrating, controlling and computing devices used in measurement, inspection, testing and control applications. Laboratory, scientific, engineering, and industrial instruments are included. The broad coverage precludes detailed discussion of physical fundamentals of every type of instrument. However, all basic methods and mechanisms are covered, including pneumatic, hydraulic, electric, and electronic instruments. The emphasis is on practical factors, and terminology is considered carefully.

Excellent tables list operating ranges, percent accuracies, recommended practices, etc. The Handbook will be revised, expanded, and republished periodically. This book sold only to *Instruments* subscribers, subscription price listed above as price of book.

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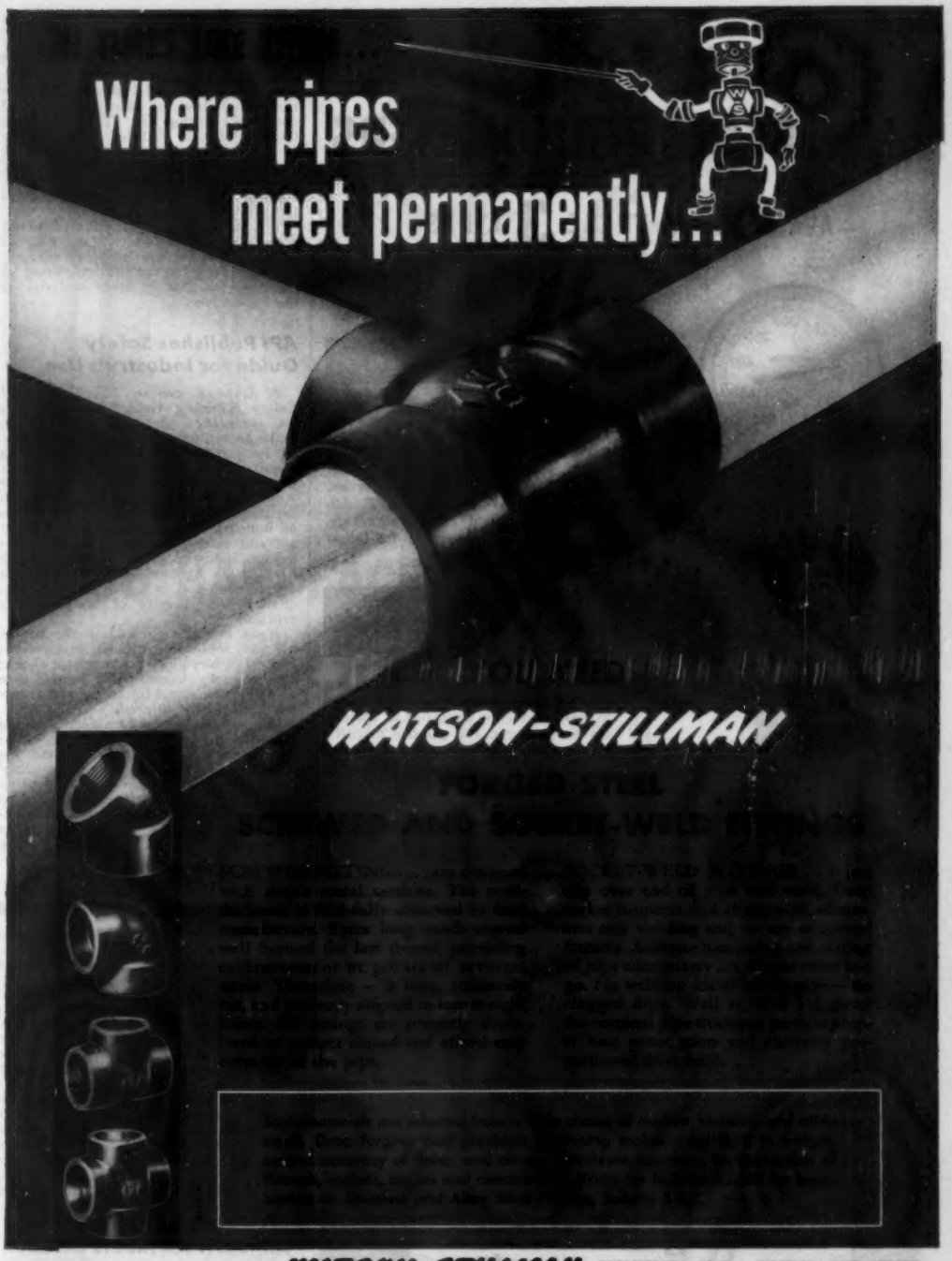

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Literature describing Weston all-metal, as well as electrical and glass thermometers, sent on request. WESTON Electrical Instrument Corporation, 638 Frelinghuysen Avenue, Newark 5, New Jersey . . . manufacturers of Weston and TAGliabue instruments.

WESTON *Instruments*

Books

produced by the Oil Industry Information Committee for distribution by oil companies during Oil Progress Week, October 14-20. Entitled "Oil Serves You," it tells the work that must be done, and the amazing total of men and materials employed in moving oil from subterranean depths to America's 150 million consumers.

The book is being distributed to oil companies, trade associations, etc., at $35 per thousand, plus shipping charges. Space is provided for the imprinting of company insignia or other material on the back cover.

API Publishes Safety Guide for Industry's Use

A training course, "First-Aid and Safety Training Guide," covering the six emergency measures necessary to make an injured person comfortable until he can receive the attention of a physician has been prepared by the Department of Technical Services of the American Petroleum Institute. The objective of the course is to expand the oil industry's long-term program of first aid and safety training. The 1950 petroleum industry safety record was the best in its history and was the fifth consecutive year in which both the frequency and severity of accidents decreased.

Basic subjects covered in the course are as follows: artificial respiration; control of bleeding; treatment for shock; care of open wounds and burns; care of dislocations and fractures; and transportation of the injured.

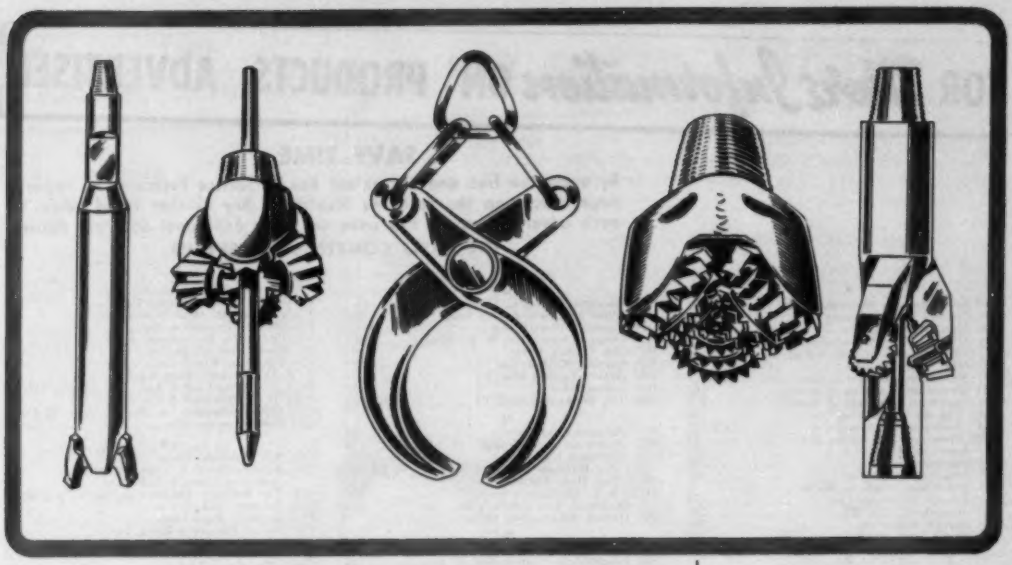
The First-Aid and Safety-Training Guide is being published in two styles and sizes, one for instructors, and the other for students. The instructors' Guide is a "Safetygraph" measuring 22x17 inches. Illustrations are printed on the face, and text on the rear. This enables instructors to stand behind the "Safetygraph" while conducting classes.

Film Narrative Stresses Instrumentation Importance

"Information At Work" is the name of the film Taylor Instrument Companies of Rochester, N. Y., has released for use by technical societies, instrument engineers, science classes, etc. The 30 minute colored moving picture depicts the growth and significance of instrumentation and is aimed primarily at audiences composed of people whose understanding of industrial instrument application would be enhanced by a sweeping view of the whole field. Sequences demonstrating control effects, instrument manufacture and instrument application will be of interest to professional men. The film can be obtained from Taylor Instrument Companies, Public Relations Dept., 95 Ames Street, Rochester, N. Y.

Annual IPAA Meets October

The twenty-second annual meeting of the Independent Petroleum Association of America will be held October 22-23 in the Shamrock Hotel, Houston. Standing committees of the association will meet Sunday, October 21.



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New Catalogs AND EQUIPMENT LITERATURE

For copies of the catalogs and new equipment literature listed, use one of the convenient Reader Service Postcards on this page. Just circle the number on the card corresponding to the number of the item in which you are interested.

Handbook on Steel

Approximately 40 different types of Allegheny Metal Stainless Steel is discussed and viewed from the standpoints of analyses, fabrication, heat treatment and special conditions of service in the book, "Stainless Steel Handbook." It is published by the Allegheny Ludlum Steel Corporation. Chapters dealing with selection of proper type of stainless steel for special application, contain a selector table with about 30 types stainless steel listed, as well as 40 of their properties broken down in the general classifications of physical data, electrical properties, heat resistance, etc.

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Volume Pumping

An illustrated bulletin on controlled volume pumping and Milton Roy Controlled Volume Pumps is published by Milton Roy Company. Bulletin 151 is of interest to industrial plants whose operations call for pumping a controlled volume of liquid in amounts as much as 50 gallons per minute or as little as three milliliters per hour. Color charts show relative corrosion resistance of materials of construction to over 170 chemicals.

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Purifiers

A general bulletin by The Centrifix Corporation illustrates and describes functions of nine types of purifiers for entrainment separation in air, steam, vapor, gas applications in power generation, petroleum refining and chemical processing fields. Special purpose purifiers described include an air intake purifier for use on compressors, engines and fans; an exhaust head to remove foreign matter from steam exhausted to the atmosphere; a scrubber purifier employing feedwater contact in two-stage separation for use in boilers and a dry scrubber purifier also for boiler application.

Circle No. 3 on Postcard

Boiler and Tank Accessories

Boiler and tank accessories of the Diamond Line are listed in Catalog No. 11 by The Steel Improvement and Forge Company of Cleveland. The catalog also contains information on forging procedures, tolerances and metal characteristics. Technical data as well as general information is included with each listing.

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New Catalogs AND EQUIPMENT LITERATURE

Use one of the free and convenient Reader Service Postcards on this page to request copies of the catalogs in which you are interested.

Glass Insulation

The Pittsburgh Corning Corporation has made available a booklet entitled "Foamglas Insulation for Piping and Process Equipment." Illustrated, it lists the properties; typical data for cold, intermediate, and hot applications; details for insulating tanks, ducts, removable covers, and tank heads; accessory materials; and prominent users and distributors. Foamglas is a cellular glass insulation. It is flexible, durable, incombustible, resistant to acids, retains its original insulating value, and resists moisture and vapor.

Circle No. 5 on Postcard

Resistance Welding

A new technical booklet on the resistance welding of nickel and high alloys has been issued by the Development and Research Division of The International Nickel Company, Inc. Designated as Technical Bulletin T-33, it contains diagrams, photographs, tables on mechanical properties, chemical compositions, recommended conditions for welding and other information.

Circle No. 6 on Postcard

Valves, Flanges, Etc.

Bulletin W-350-B5C describing valves, flanges, hose nipples, bars, welding electrodes and screw machine products is issued by Worthington Pump and Machinery Corporation, Harrison, N. J., and offers illustrations and specifications tables. Bulletin W-350-B4 carries information on physical and chemical properties, analysis, corrosion resistance, machining and welding practice.

Circle No. 7 on Postcard

Metallizing Economy

Metallizing applications that save time, money and materials are the subject of the current issue of Metco News, Volume 5, No. 9, published by Metallizing Engineering Company, Inc. One suggestion was the re-metallizing of worn rods and parts as wear occurs, thus eliminating replacement of parts. When a rod breaks or is otherwise damaged beyond repair, it was suggested that a rod could be turned out of ordinary cold rolled steel and the surface metallized with stainless steel. Average cost of salvage to a Pennsylvania refinery used as an example ran about 16 percent; in one year the refinery saved 4000 pounds of alloy steel and 2200 man hours.

Circle No. 8 on Postcard

Spot-Cooling Device

Three models of Belmont Hilech Vortex Tubes are cataloged in a Thermo Instruments Company leaflet, Form V-2-551. An internal vortex is utilized to separate a flow of compressed air (or other gas) into hot and cold fractions which can be used in a wide variety of ways for calibrating instruments, cycle-testing equipment, cooling thermocouples, etc. Operating-characteristic curves are provided to show temperature drop below that of inlet air over a range of 15 to 82 degrees and rate of flow for various input pressures.

Circle No. 9 on Postcard

[More Literature Items on Pages 257, 259, 261, 263 and 265.)

PETROLEUM REFINER Reader Service Postcard – September, 1951, Issue*

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ADVERTISEMENTS—Circle key number of ad for more product information.

A1	B1	C1	D1	E1	F1	G1	H1	J1	K1	L1	M1	N1	P1	Q1	R1	S1	T1	U1	V1
A2	B2	C2	D2	E2	F2	G2	H2	J2	K2	L2	M2	N2	P2	Q2	R2	S2	T2	U2	V2
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Company_____ Position_____

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PETROLEUM
REFINER

BOX 2608

HOUSTON 1, TEXAS, U. S. A.

USE THESE CARDS To Get COPIES OF CATALOGS And for More Information on NEW EQUIPMENT ADVERTISED PRODUCTS

NEW EQUIPMENT and Manufacturers' Literature

KEEP INFORMED by requesting additional information on new equipment and services described here. SAVE TIME by using the Reader Service Postcards on opposite page. Circle number on card corresponding to the number listed at the end of each new equipment item on which you desire additional information.

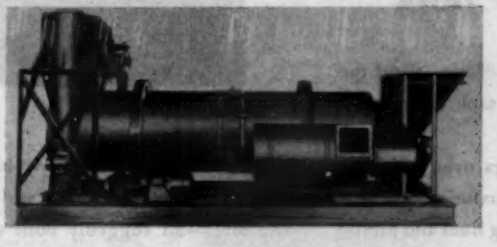
Extinguisher Gun

American-LaFrance-Foamite Corporation has designed and marketed a new one quart air-pressurized fire extinguisher which discharges vaporizing liquid fluid for extinguishing both flammable liquid and electrical type fires. It aims and operates like a gun. Easily recharged by simply pouring in more vaporizing liquid, it can be pressurized with any standard air chuck. Known as the Alfco Pressurized Fire-Gun, it carries the inspection and approval label of Underwriters' Laboratories for Class B and C fires. Literature available.

Circle No. 10 on Postcard

Packaged Drying Unit

A packaged drying unit for the drying of chemical products, raw materials, synthetic compounds, etc., is being marketed by the Patterson Foundry & Machine Company. Built in standard sizes, the unit is available in plain or stainless steel, and with white acid-resistant and abrasion-resistant Porov linings. It consists of a rotary dryer with drive, screw feeder, air heater, fan and dust collector integrally mounted on a steel frame. Materials are fed continuously by means of a special feeder directly to the sanitary interior of the dryer. An uncontaminated, uniformly dried product is discharged continuously.



Circle No. 11 on Postcard

Steam Traps

A new supplement to Yarnall-Waring Company's Yarway catalog is off the press. The "Steam Trap Selector" is said to be particularly useful for engineers who have many applications for steam traps. The catalog treats steam process equipment, industrial space heating equipment, steam generation and distribution equipment. Bulletin T-1750.

Circle No. 12 on Postcard

Flow Ratio Controller

A new catalog describing Fischer & Porter Company's automatic flow ratio control systems is now available. The principle of operation is described as well as the fundamental reasons for improved ratio control. A list of typical applications is included.

Circle No. 13 on Postcard

Photocopying

Remington Rand says that maximum ease and flexibility in photocopying engineering drawings and other large-sized originals is assured with its newly improved Vacuum Seal Portagraph. A contact printer, the Vacuum Seal Portagraph comes in two models, one with a copy surface area of 30 x 42 inches and the other with a 42 x 60 inch area. Both models are finished in walnut. Principal feature is a singe set of white lamps which provide varying degrees of light intensity for contact printing. A set of two lights in the instrument panel is an innovation for use under subdued light or darkroom working conditions. One light illuminates the timer dial and the other is for inspecting the vacuum gauge reading.

Circle No. 14 on Postcard

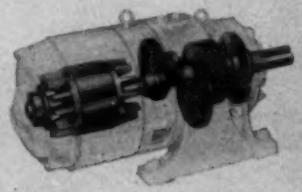
"Dimethoxy"

Dimethoxy tetraethylene glycol, a selective solvent with the unique property of miscibility with both water and organic compounds, is available again from Ansul Chemical Company. Ansul reports the solvent power of the high boiling ether (275° C.) may be changed by dilution with water or hydrocarbons. The chemical contains no active hydrogen atom and may be efficiently used as a reaction medium for Grignard and sodium condensation reactions. This material has been tested successfully as an additive to hydrocarbon diesel fuels to reduce the auto-ignition temperature of the fuel for cold starts.

Circle No. 15 on Postcard

New Gear Principle

Two secondary pinions to drive the output gear, is the feature of Type GL Syncrogear, manufactured by U. S. Electrical Motors, Inc. The effective torque rating of a conventional single pinion and gear unit is said to be doubled in the Type GL. Incorporating the use of a splined herringbone pinion to equally divide the load between the two secondary pinions, the Type GL



produces high torque at low speeds while occupying only a fraction of space required of a conventional drive, according to U. S. Motors engineers. Available with 5 to 25 hp. ratings and speeds from 30 to 84 rpm, it has asbestos-protected windings, normalized castings, solid centricast rotors and Lubriflush lubrication.

Circle No. 16 on Postcard

Refractory Cement

R & I Super No. 3000 Refractory Cement is a bonding and patching mortar manufactured by Refractory & Insulation Corporation. It is a high alumina base refractory material that withstands working temperatures up to 3000° F. Mixed to a heavy plastic, sticky consistency, it is easy to trowel and patch, making a rigid, weld-tight joint with the material it covers. It air sets to full strength and flint-like hardness, withstanding abrasion by gases or solids moving over it at high speed.

Circle No. 17 on Postcard

Safety Goggles

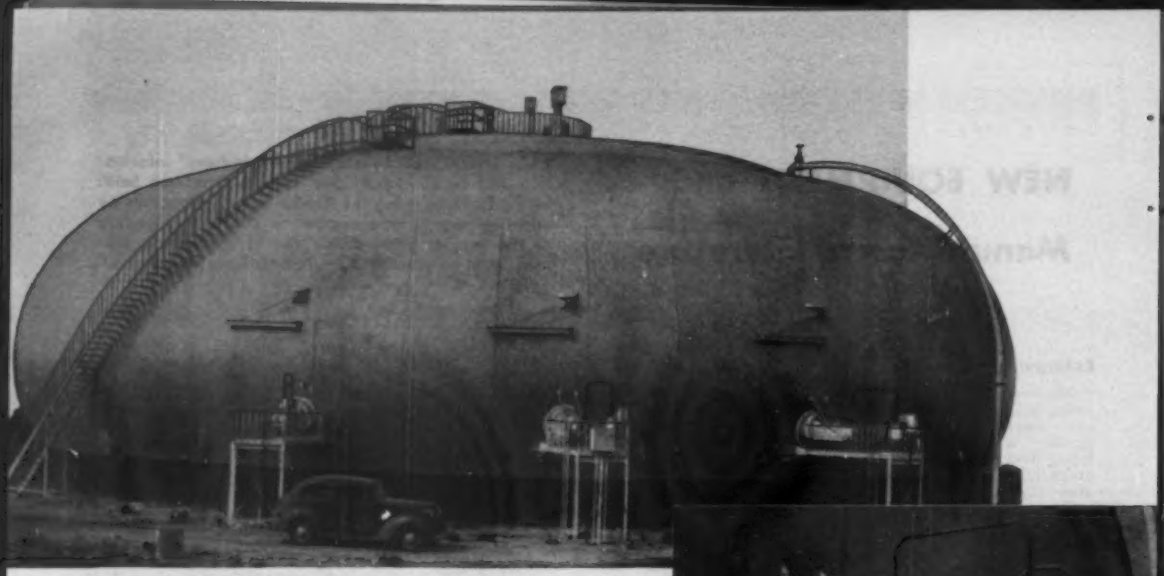
A new 6-curve plano plastic lens for industrial safety goggles is announced by Willson Products, Inc. Known as Plas-Tough, the new lens is made of a newly developed plastic with an improved surface hardness that has "unusual resistance to scratches, abrasions and common industrial acids that mar ordinary plastics." It is exceptionally light weight, about half that of comparable glass lenses. On jobs where lens pitting is a factor, Plas-Tough serves much better than glass, and is also superior to cellulose acetate.

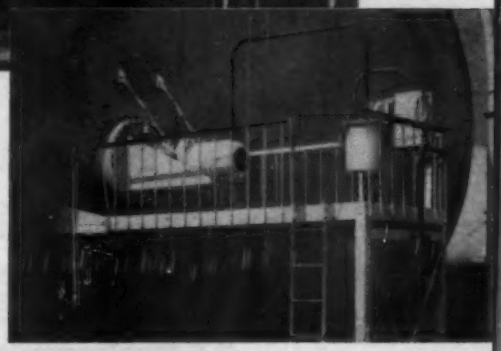
Circle No. 18 on Postcard

Portable Mixers

A new catalog entitled "A Rational Approach to Mixer Selection," published by International Engineering, Inc., contains interesting and valuable information on portable mixers. Bulletin No. 74-G is free.

Circle No. 19 on Postcard





ONLY 75 HP NEEDED TO BLEND THIS TANK

Three 25-horsepower *Lightnin Mixers* blend the contents of this 100,000-barrel tank in less than two hours.

Purchased for obvious savings over recirculating pumps, the mixers cost approximately $5,000. They eliminate the need for swing lines and piping that, by themselves, would have cost more than this.

Lightnin Mixers fit old tanks as well as new ones. Existing manways may be used. *Lightnin Mixers* can be repacked from outside the tank, while it is under a full head of liquid.

Many *Lightnin Mixers* have been on the job 20 years and more. There is a wide range of models and sizes—all ruggedly built of standard interchangeable components to simplify upkeep. Every *Lightnin* is factory aligned, and guaranteed to do the job you want it to do.

Write for complete information, or check and mail the coupon for descriptive literature.

MIXING EQUIPMENT Co., Inc.
(MIXCO)
164 Mt. Read Blvd., Rochester 11, N. Y.
In Canada: William & J. G. Greey, Ltd., Toronto

Please send me the literature checked:

- ☐ B-76 Side Entering Mixers
- ☐ DH-50 Laboratory Mixers
- ☐ B-78 Top Entering Mixers (Propeller Type)
- ☐ B-52 Condensed Catalog showing complete line
- ☐ B-89 Top Entering Mixers (Turbine and Paddle Type)
- ☐ B-75 Portable Mixers (Electric and Air Driven)

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LIGHTNIN PORTABLE MIXERS
World's largest-selling line. Electric or air motor, direct or gear drive. Sizes ⅛ to 3 HP.

LIGHTNIN SIDE ENTERING MIXERS
For tanks up to 5 million gallons. Gear motor or V-belt drive; motorless types. Sizes 1 to 25 HP.

LIGHTNIN TOP ENTERING AGITATORS
Turbine, propeller and paddle types. For open or closed tanks. 16 speeds available in new heavy duty drive. Sizes ⅛ to 200 HP.

A COMPLETE LINE . . . UNEXCELLED TECHNOLOGY

To obtain additional information or literature use free Reader Service Postcard opposite page 257. Circle number on card corresponding to number listed at end of each item on which more data or literature is wanted.

Dust Mask

Labor efficiency through protection of workmen from nuisance dusts is the promise made by General Scientific Equipment Company for its G-S No. 33 Dust Mask. The mask is not built for use in atmospheres of toxic dust, silica, or fumes. The mask is efficient for nuisance dusts because it is washable and sturdy enough for continuous use, and inexpensive enough to be discarded. The vegetable fiber of the mask will not dissolve in water or live steam, and can be autoclaved or sterilized in boiling water. Although long wearing, the mask material is said to lie soft, porous, absorbent and free from irritating lint or yarn.

Circle No. 20 on Postcard

Safety Booklet

Mine Safety Appliances Company has published an illustrated booklet which will be given with every new MSA Skullgard. The booklet points out the vital importance of adequate head protection by listing eight representative examples from the many in MSA files. A section of the booklet is devoted to the care of the Skullgard. Proper precautions prolong the life of the hat. Design features are discussed in the booklet. Copies available.

Circle No. 21 on Postcard

Finned Tubes

Comparison of heat transfer values of plain copper tube and Wolverine Trufin, of copper construction, with 19 fins per inch, when applied to tankless water heater coils, is the description contained in Wolverine Tube Division's Data Sheet 651-E. Finned tubes, it is pointed out, can be used to economic advantage by placing the fins on the low velocity water side. Both water-to-water heat transfer applications, the difference in velocities is such that a difference is effected in the film coefficient. This difference is small, and the type of finned tube selected should be of the low finned type as the ratio of outside to inside surface area, in general, should be in direct proportion to the film coefficient.

Circle No. 22 on Postcard

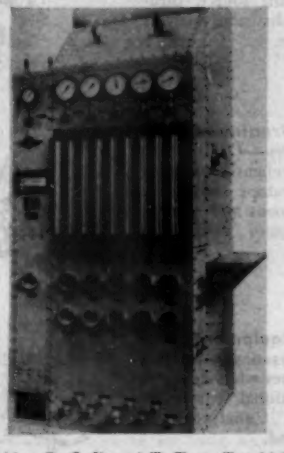
Chemical Service Pump

Latest bulletin published by the Warren Steam Pump Company is devoted to description and specifications for Type "G" Pump. This pump is designed for process and chemical plants having semi-critical requirements. It is available in 1, 1¼, 1½ and 3 inch discharge sizes and heads to 240 feet. The bulletin also includes a selection chart and external and sectional views of the pump.

Circle No. 23 on Postcard

Air Separation

Petrocarbon Limited has published a booklet describing their air separation plants for oxygen, nitrogen and the rare gases. First plants of their kind to be manufactured on a commercial scale in Great Britain, they are for large or small scale production of gases. Four types of plants are described in the



booklet, R, S, D and T. Type T, which is pictured, is designed for oxygen or nitrogen plants for outputs of 200 cubic metres of oxygen per hour or more. The unit utilizes low pressure air only and has replaced the expansion engine with a turbine. The turbine is compact, has only one moving part and no sliding surfaces at low temperature. A single low-pressure (75 psig.) air compressor is used for economy, reliability and ease of maintenance.

Circle No. 24 on Postcard

Cupcase Thermometer

Narrow enough to fit into two-inch gauge pipes in oil storage tanks, the new Cupcase Thermometer by TAGliabue Instruments Division of Western Electrical Instrument Corporation meets ASTM specifications and is accurate and easy to read. This TAG Model 8657 has a cup capacity of 100 milliliters as compared with smaller types of from 20 to 60 milliliters capacity. The thermal inertia resulting from the larger capacity provides greater resistance to temperature change as the thermometer is raised from reading depth and passes through varying temperatures at other levels. It is available in two scale ranges: 0 to 180° F. and from —30 to 120° F.

Circle No. 25 on Postcard

Electronic Potentiometer

Applicable to all industries where the larger and longer chart, combined with pneumatic control, is desired, the new electronic potentiometer developed by the Brown Instruments Division of the Minneapolis-Honeywell Regulator Company utilizes a full 120 foot long, eleven inch calibrated width chart. It has a ten percent proportional band, a 150 percent proportional band and manual reset, or a 150 percent proportional band and automatic reset.

Circle No. 26 on Postcard

Safety Controls Data

Popular McDonnell & Miller safety controls are covered in the new McDonnell Products Supplemental Catalog. The eight products described are: Boiler water feeders, Make-up water feeders for receivers, Low water fuel cut-offs, Float operated switches, Small float valves, Solvent still regulators, Electrical switches and Flow switches. Listing contains description, price, and pertinent information.

Circle No. 27 on Postcard

Packings

A new booklet by Raybestos-Manhattan, Inc., Packing Division, describes R/M Duck and Rubber Packings, including low pressure, cross expansion, hydraulic, hollow core, round rubber core and diagonal expansion types. The bulletin gives service recommendations for each type packings, lists the standard sizes in which each is available and gives complete packaging specifications on all types.

Circle No. 28 on Postcard

BIRD-ARCHER'S COMPREHENSIVE 8 POINT WATER TREATMENT SERVICE

Even if your present water treatment methods appear satisfactory, it will pay you to look into Bird-Archer's 8-point water treatment service. Any or all of this comprehensive, efficient service is available to you. Talk to your Bird-Archer representative about it next time he calls. Or, write us now to arrange a consultation. No obligation, of course.

What Bird-Archer Does

1. Surveys Plant—Bird-Archer makes a complete study of plant operation involving the use of water or steam . . . checks present equipment and past performance.

2. Studies All Available Water — Starting at the source, Bird-Archer makes exhaustive analyses of water supplies.

3. Develops Treatment and Control Systems—On the basis of these comprehensive studies, Bird-Archer develops a complete system of treatment and control, including necessary operational changes.

4. Specifies Equipment that May Be Necessary — Bird-Archer determines whether installation of additional equipment will be helpful . . . analyzes benefits to be derived.

5. Furnishes Proper Chemical Treatments When Required—For more than a half century, Bird-Archer has manufactured specifically formulated treatments to solve individual problems.

6. Instructs Plant Staff—Plant personnel is carefully instructed by experienced technicians in the application of treatment and control . . . teaches simple, accurate test procedures.

7. Makes Periodic Check-Ups —To make certain that the recommended system is providing the best possible results, a Bird-Archer Service Engineer makes regular, personal check-ups.

8. Offers a Laboratory Service for Scientific Analysis—Modern Bird-Archer laboratories, staffed by trained chemists, specialize in water analyses and research . . . check accuracy of plant control.

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WATER TREATMENT

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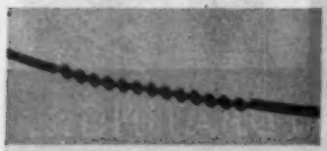
IN CANADA: The Bird-Archer Co., Limited, 503 McGill Building, Montreal
IN MEXICO: Calderas y Accesorios, S. A., Amsterdam 291, Mexico, D. F.

To obtain additional information or literature use free Reader Service Postcard opposite page 257. Circle number on card corresponding to number listed at end of each item on which more data or literature is wanted.

Expandable Strapping

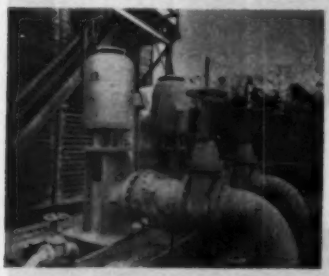
A steel strap that "stretches and snaps back like a spring" is the latest achievement of A. J. Gerrard & Company. Expand-R-Strap was developed in answer to a definite need for a strap to hold insulation snugly around tanks, etc., which expand and contract in circumference. The new strap is a corrugated tempered corrosion resistant stainless steel possessing a spring-like quality. It is regularly furnished in 320 foot coils. Five feet corrugated and five feet plain strap alternate along the entire length.



Circle No. 29 on Postcard

Vertical Pumps

Ingersoll-Rand Company has prepared a catalog describing Class APH-APK line of vertical, turbine-type pumps which are applicable to bulk liquid transfer, cooling tower, etc., and service where suction is taken from an open source. Available in single or multi-stage construction, with any desired column length, pump sizes range from 6 to 30 inches, for capacities to 15,000 gpm and pressures to 250 psi. Two size 16 APH pumps are pictured on a cooling tower circulating service.



Circle No. 30 on Postcard

Alloy Steel Tubing

Problems involving alternate grades of medium carbon is offered in a new four-page bulletin published by The Babcock & Wilcox Tube Company. It presents condensed data on microstructure, critical points, effect of alloy elements, etc., for 14 alloy steels used in the production of tubular parts.

Circle No. 31 on Postcard

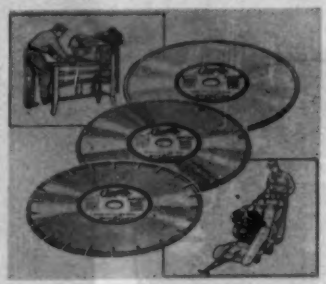
Manifold Discharge Piping

A manual by Farris Engineering Corporation proposes an approach to the design of discharge header systems based upon the partial or complete elimination of back-pressure effects on tied-in safety-relief valves. Claimed to offer typical savings of approximately 75 percent on the cost of conventional discharge piping, this manual gives operating test data on the company's complete line of FarriSeal and BalanSeal bellows-type Safety-Relief Valves, as well as data of general interest to the engineer.

Circle No. 32 on Postcard

Masonry Saw Blade

Clipper Manufacturing Company has adapted the diamond blade to the cutting of concrete and asphalt. It is said that streets, building floors, drives, walks, runways, etc., can be cut with Clipper Diamond Blades and a Clipper Concrete Saw. This blade is an addition to the series designed for cutting hard-vitreous materials on masonry saws. The manufacturer claims that concrete containing limestone aggregate can be sliced up to ten feet per minute when cutting at a depth of one inch. The blades are manufactured in diameters from 8 to 18 inches and in thicknesses of 5/32 to 7/64 inches.



Circle No. 33 on Postcard

Sealing Compound

A new compound for sealing gaskets and threaded joints of many types is being manufactured by the Chicago Gasket Company. Known as Graycote, it is compounded of six basic ingredients, chief of which is a spongy metallic pigment locked in a new type of insoluble vehicle. Retention in the no-drying vehicle keeps the compound soft, creating a permanent seal but allowing units to be easily disassembled after long periods of time. It also lubricates threads to reduce wrench torque and allow additional takeup. The manufacturer claims it is ideal for sealing gasoline, distillates, LP gases and jet engine fuels.

Circle No. 34 on Postcard

Level Control

According to Fielden Instrument Corporation, the Model AJ-1 Tektor makes possible the level control of practically all liquids and solids. Electrical contact is not necessary with the material under control. The model is housed in a dust-tight, splash-proof, die-cast aluminum box with a screw-on cover. The electrode, a simple probe, is inserted into the container at the level at which control is required. A level differential of 1/32 to ¼ inch may be obtained. Other models are available.

Circle No. 35 on Postcard

Transformer Welder

Designed for general maintenance and production welding, the Airco Model MCM 200 ampere transformer welder manufactured by Air Reduction Magnolia Company, is a rugged unit with easy-to-operate controls. Built for long, dependable service in job shops and industrial plants, MCM has a full 200 ampere, 50 percent duty cycle, and NEMA rating with four variations available: 220 volt or a 220/440/550 volt unit, each with or without power factor correction. Two open circuit voltages are provided, 80 volts on the low range and 55 volts on the high range.

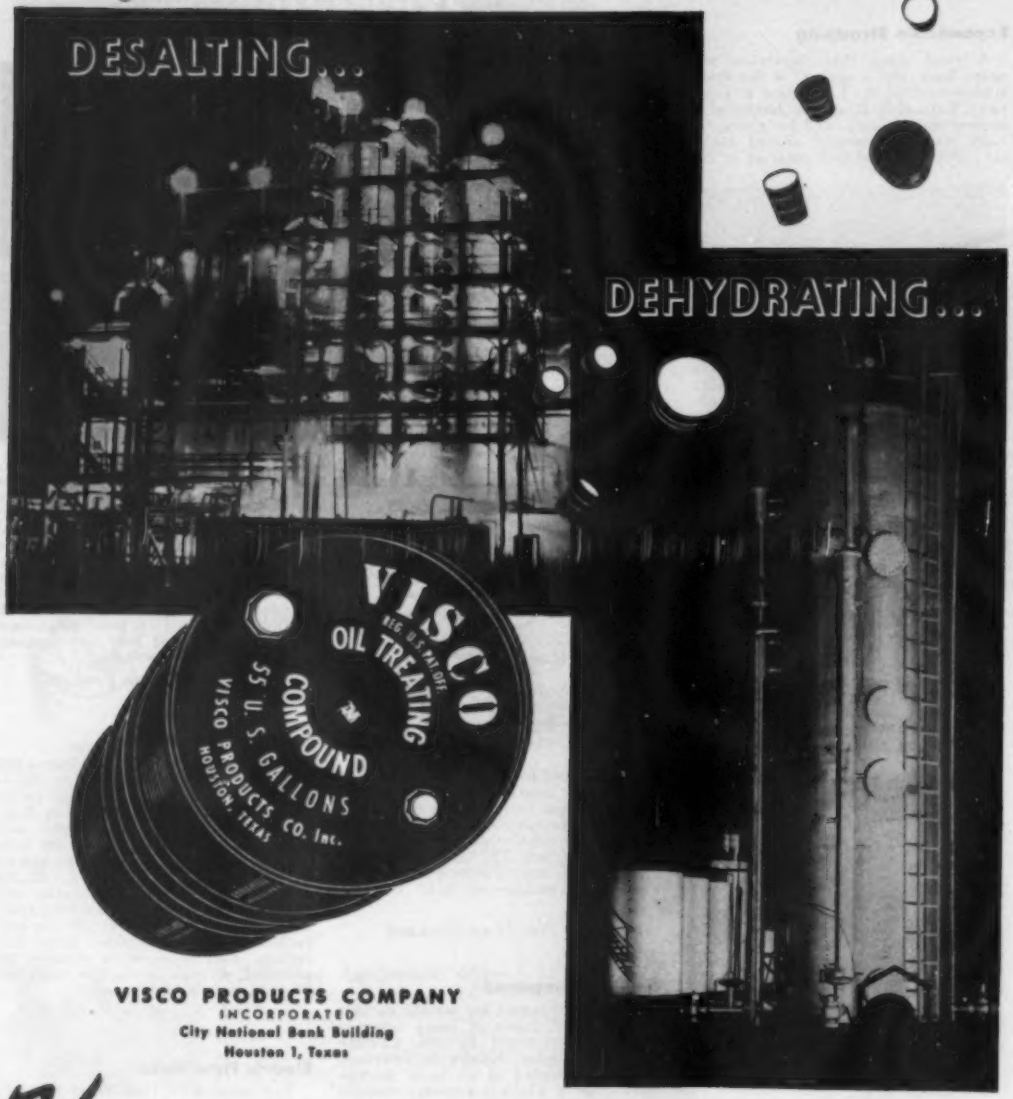
Circle No. 36 on Postcard

Electric Flow Meter

Instrumentation Data Sheet No. 7.2-2 by Minneapolis-Honeywell Regulator Company, Industrial Division, describes metering flows in crude oil or refinery products pipe lines and outlines the operating principles and application of the Brown electric flow meter system. The bulletin describes how differential pressure type flow records are employed in the operation of pipe line pumping stations to assist in locating the source of a line pressure drop.

Circle No. 37 on Postcard

Visco CONSISTENTLY EFFICIENT EMULSION BREAKING



VISCO PRODUCTS COMPANY
INCORPORATED
City National Bank Building
Houston 1, Texas

Visco

DEHYDRATING AND DESALTING CHEMICALS ● WHEREVER COST AND EFFICIENCY COUNT

NOTICE: Visco Products Company is authorized to manufacture and sell Visco Oil Treating Compounds for use in the breaking and resolving of oil emulsions, or to grant licenses for such use, under the following United States Letters Patent: 2,050,539; 2,050,540; 2,206,569; 2,214,703; 2,214,704; 2,225,189; 2,303,414; 2,307,813; 2,316,054; 2,316,055; 2,321,056; 2,355,554; 2,454,806; 2,314,398. Visco Products Company is willing to grant licenses on a royalty basis, to oil companies, and to others desiring to practice the patented subject matter, under any and all of the above Letters Patent, permitting the user to purchase the oil treating compounds at will from any vendor, or to prepare the compounds for use or to use the compounds under the above Letters Patent. Application for license should be made to: **Visco Products Company**, Houston, Texas.

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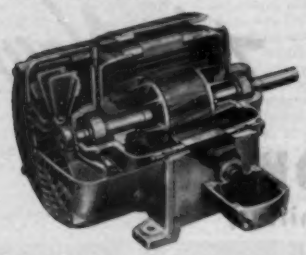
Enclosed Motor



An enclosed motor for explosion-proof requirements has been developed by U. S. Electrical Motors, Inc. Made in capacities from three to 75 hp., Types SE and SES carry the Underwriters' label in Class I, Group D, for highly inflammable gases and volatile liquids; and in Class II, Groups F and G, for combustible dusts. Features incorporated include a sealed terminal, elongated spark-arresting bearing sleeves, stream-lined housing, hi-draft ventilation, removable cover, split hub fan, and others. Bulletin No. 1629 describes the motors.

Circle No. 38 on Postcard

Turbine Maintenance

Bulletin 832-P, published by Bowser, Inc., describes turbine oil conditioning (dry type) for turbine generators, blowers and exhausters, etc. The importance of continuous oil maintenance, and the factors which cause turbine oil deterioration are fully explained by charts, diagrams and phantom views. Various types of turbine oil maintenance systems are shown with their capacities and dimensions. The bulletin also covers a system for maintaining insulating oil dielectric in transformers, circuit breakers and switches.

Circle No. 39 on Postcard

Sludge Solvent

Actual tests with Magnusol HD, an emulsifiable solvent cleaner manufactured by the Magnus Chemical Company, have proved that a spray of Magnusol HD, mixed with distillate in 1:10 proportions, will loosen bunker sludge and other residue from tanks and other containers. By the time a man, clothed in a safety suit, has completely sprayed such a tank, the bond of muck and sludge to metal surfaces of the tank is loosened and the sludge can be flushed off completely. The operation is carried out at normal temperatures and there is no possibility of attack on the metal according to Magnus Chemical Company.

Circle No. 40 on Postcard

Cast Irons

"Nickel Alloyed Cast Irons, Guide to the Selection of Engineering Irons" is the latest reference bulletin published by The International Nickel Company, Inc. Compiled primarily for design engineers, it presents many valuable characteristics of modern nickel cast irons and illustrates their broad acceptance throughout industry. Illustrations indicate wide industrial usage, in all sizes and shapes, to which nickel has been put.

Circle No. 41 on Postcard

Linear Pressuregraph

The Electro Linear Stabilized Pressuregraph manufactured by Electro Products Laboratories is based on a system of carrier modulation. It provides linear measurement and records

pressure-time studies of static, dynamic and transient pressures in air, gasses, water and viscous liquids. The linear outline is viewed directly on the oscilloscope; drift and temperature is stabilized; pressure range is from .5 to 10,000 psi; frequency response ranges from 0 to over 20,000 cps; while 200,000 separate pressure measurements per second are made. A regulated DC anode and bias voltage is built in for power supply.

Circle No. 42 on Postcard

Corrosion Research

The nature of corrosive attack on copper and copper alloys is the subject of a booklet published by The American Brass Company. The technical staff of this company has been studying the problem for 25 years and "Corrosion Resistance of Copper and Copper Alloys" is a summary of their findings. It explains the chemical and physical nature of corrosive attack in its various forms. Included is a tabulation indicating the relative corrosion resistance of the principal types of copper and copper base alloys when in contact with 183 different corroding agents.

Circle No. 43 on Postcard

Flow Meter

A new mercuryless flow meter, said to feature fast speed of response for flow control and continuous range change adjustment from 0-20 to 0-200 inches of water, is described in Minneapolis-Honeywell's Brown Instrument Division catalog Number 2281. Operating principles of this pneumatic-balance type flow transmitter are covered, as well as construction features, typical applications, detailed specifications, and installation methods.

Circle No. 44 on Postcard

Condensate Return Unit

An easy-to-use selection table published by Roy E. Roth Company, enables rapid and accurate selection of the correct Roth Vertical Condensate Return Unit to fit specific needs. Table gives EDR square feet, capacity in gpm, receiver capacity in gallons, and range of models according to boiler pressure. Description of units and specifications included.

Circle No. 45 on Postcard

Cathodic Protection

Cathodic protection for the high-heat, high-pressure cracking process prior to storage eliminates electrolytic corrosion in the open-type condenser boxes in a large Cleveland petroleum refining plant. Special electrodes were immersed in the water from the top of the open boxes and direct current was impressed on these electrodes which radiated through the water to the metal surfaces of the piping and the box. The current entered the metal surfaces and prevented the electro-chemical action which caused corrosion. One of many installations engi-

neered by The Harco Corporation, it utilizes specially designed selenium rectifiers. Catalog No. C-142 describes complete installation of this system in petroleum refineries.

Circle No. 46 on Postcard

A Big Forward Step In The Measurement and Transmission of Flow

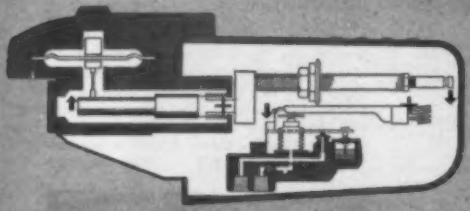
INTRODUCING *the New*

BROWN DIFFERENTIAL CONVERTER

(pneumatic-balance flow transmitter)

Easy Field Calibration –without water column

No Strainers Required



Functional schematic cross-section of the Brown Differential Converter . . . showing its utilization of the pneumatic-balance principle.

Easily Cleaned

Wide Rangeability –in one unit, 20 to 200" H_2O

Fast Speed of Response

Easy to Install

No Mercury or Seals

AFTER long and rigorous testing in the field, the Brown Differential Converter is ready to set new high standards of simplicity and precision in the measurement and transmission of flow.

Operating on the pneumatic-balance principle, this compact and lightweight unit converts differential pressure at the orifice into a proportionate output air pressure which is a measure of flow. Range is continuously adjustable, from 0-20 to 0-200 inches of water. All adjustments are easily and simply made, without special tools or extra parts.

Applicable to a wide range of continuous processes, the Brown Differential Converter is the forerunner of an entirely new series of pace-setting developments made possible through Brown *Creative Instrumentation*. For detailed information write for a copy of new Catalog 2281 . . . and call in our local engineering representative for a discussion of your process needs. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4498 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS **Honeywell**

Brown Instruments

To obtain additional data use free Reader Service Postcard opposite page 257. Circle number on card corresponding to number listed at the end of each item on which more data or literature is wanted.

Multiple Point Controllers

Celectray models of Multiple Point Indicating Potentiometer Controllers are built by the TAGliabue Instruments Division of Weston Electrical Instrument Corporation. Battery of engine test stands pictured, includes ten TAG Celectray Multiple Point Indicating Potentiometer Controllers used to control temperatures in the flow of additional cooling water or steam to engine jackets, oil heat exchangers, etc. The unit is in operation at Shell Oil Laboratory at Martinez, Calif. Each unit has six control points for controlling six tests at one time with one instrument.

Circle No. 47 on Postcard

Rust Prevention

Petrobase 210, manufactured by Pennsylvania Refining Company, is a synthetic rust preventive composition which imparts effective rust preventive properties to petroleum oils, petrolatums and waxes. Due to inherent polar activity, Petrobase 210 used in small quantities causes oils and waxes to displace water from metal surfaces. This property also prevents redeposition of aqueous vapors or liquids on the metal surface. Petrobase 210 offers humidity protection, acidic emulsion or solution displacement and salt water immersion and spray protection as well.

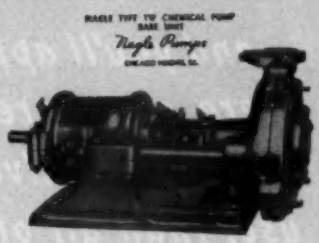
Circle No. 48 on Postcard

Refractories

"Super Refractories" is the name of a booklet released by The Carborundum Company. The construction material of the refractories offers resistance to corrosion and abrasion, high hot strength, chemical inertness, and a wide range of thermal conductivities. The booklet treats each of the above properties in detail, lists physical characteristics and contains photos illustrating various shapes.

Circle No. 49 on Postcard

Chemical Pump



"TW" Chemical pump is a recent addition to the line carried by Nagle Pumps, Inc. Available with direct coupled motor, V-belt drive or overhead mounted motor, it features open, high efficiency impeller, with low entrance losses for operation under low n.p.s.h. conditions. The impeller is screwed on the shaft. The chemical pump is available with impeller and housing of various alloys for handling corrosive liquids; large shafting and bearings; double stuffing box. Water-end has clamp ring assembly which eliminates studs and tapped holes. Convenient slippage seal adjustment compensates for wear or unequal expansion. Split bearings are held together by bolts and nuts and can be dismantled with ordinary wrenches, or burned or chiseled off if badly corroded, without harming structure.

Circle No. 50 on Postcard

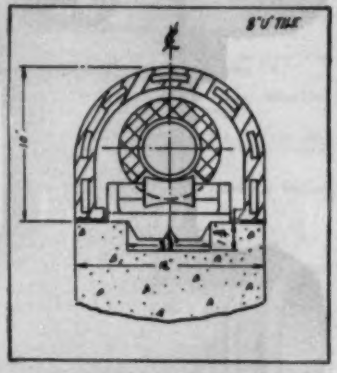
High Temperature Insulation

Fibrous silica insulation, Refrasil, was first developed by The H. I. Thompson Company for installation in jet aircraft. Further investigations have proved the insulation adaptable to thermal and electrical insulation problems in chemistry, petroleum, electronics, etc. The photo shows the physical forms of Refrasil. A typical new use is for sleeving as electric space separators in thermocouple leads. The sleeving may be applied with maximum effectiveness where temperatures up to 1800°F. are encountered. Its light weight, minimum bulk and flexibility, make Refrasil desirable for specific insulation problems.

Circle No. 51 on Postcard

Tile Pipe Conduits

Porter-Hayden Companies, Insulation Engineers and Contractors, offer a U-Tile Type Conduit as shown in the illustration. One-pipe installations, or installations having several small pipes require the "U" Type. "U" Tiles are shipped to the job as flattened cylinders, scored longitudinally on both flattened sides. Tapping over each scoring with a hammer splits the cylinders into two "U" tiles. The photo shows one of the halves in section, the "U" being up-side-down. Circumferential scoring at one end of the tile is chipped off to provide a rough-edged bevel which permits the jointing mortar to key and bond into the channels formed within the tile sections.



Circle No. 52 on Postcard

Industrial Gratings

Bulletin RR-250 is a publication by A. O. Smith Corporation describing "Industrial Floor Gratings and Stair Treads." Four factors are stressed: Serrated safety tread in both bearing bars and cross bars assure positive non-slip protection; maximum open area admits a greater percentage of light and ventilating air; easy to maintain because "locked-for-life" construction eliminates repair and misalignment problems; self-cleaning because of absence of acute angles between bearing bars and cross bars eliminates dirt-catching pockets.

Circle No. 53 on Postcard

Miniature Speed Drive

A miniature variable speed drive with push rod ratio control is described by Metron Instrument Company's technical data sheet 4C. The ratio of the instrument is variable from 1/6 to 6 by a total travel of 0.375 inches of the push rod. Applications are for power devices requiring remote or automatic control.

Circle No. 54 on Postcard

CHECK ALL THESE FEATURES . . .
. . . and you'll appreciate why there are more LimiTorque Automatic Valve Controls in use, than all others.

1. Micrometer torque seating switch.
2. Self contained unit—no gears, nut or bearings to buy.
3. Weatherproof, dust-tight and watertight construction.
4. Hammerblow device.
5. Non-rotating handwheel built into the unit.
6. Automatic declutching.
7. Motor is disengaged during handwheel operation.
8. Can always be declutched for handwheel operation regardless of weather or electrical conditions.
9. High torque motors.
10. Simple valve yoke.
11. May be mounted in any position.
12. Three to four times faster handwheel operation.

This Unit is mounted on top of valve yoke . . . Stem nut is inside and furnished with LimiTorque Unit. Nut is directly inside worm gear which drives it. (All clutches and connecting sleeves are eliminated.)

The LimiTorque is designed for plug, butterfly, gate and globe valves up to 96" diameter . . . Entire Unit and nut can be lifted off valve yoke, by removing flange bolts.

A special high starting torque motor, reduction gears, limit switches are all in one weatherproof assembly—and all electrical connections are made to terminal boards, easily accessible by removal of watertight cover . . . heat treated helical gears and hardened, ground and polished worm and bronze worm gear are used.

The usual Limitorque "hammerblow" device allows motor to reach full speed before load is engaged. This imparts the "hammerblow" necessary to unseat sticking valve.

Torque seating switch insures tight valve closure without strain on valve parts. Protection from damage due to a foreign object obstructing closing is provided during entire closing operation because motor is shut off by thrust exerted on valve disc.

Actuation may be by any available power source such as electricity, air, oil, gas or water.

Write for Catalog L-50 for complete details. Please use your Business Letterhead.

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

Catalogs AND EQUIPMENT Literature OFFERED IN THIS ISSUE'S ADVERTISEMENTS

Copies may be obtained easily and without cost by using Reader Service Postcard. Just circle on the card the identifying key number of each item in which you are interested. Postcards are opposite page 256.

TUBE CLEANING AND MAINTENANCE—Bulletins. Airetool Manufacturing Co. See advertisement page 325.
Circle A2 on postcard.

STEEL FLOOR PLATE—Booklet B-18. Alan Wood Steel Co. See advertisement page 298.
Circle A3 on postcard.

PETROLEUM PUMP—Bulletin 52B7638. Allis-Chalmers Manufacturing Co. See advertisement page 7.
Circle A4 on postcard.

CENTRIFUGAL BLOWERS—Catalog. Allis-Chalmers Manufacturing Co. See advertisement page 9.
Circle A5 on postcard.

FREE BOOKLET—Alcoa Aluminum Heat Exchanger Tubes. Aluminum Company of America. See advertisement page 14.
Circle A7 on postcard.

ACTIVATED ALUMINA—Literature. Aluminum Company of America. See advertisement page 185.
Circle A8 on postcard.

CATALYSTS—Literature. Aluminum Company of America. See Advertisement page 279.
Circle A9 on postcard.

CATALYST AND CHEMICALS—Literature. American Cyanamid Co. See advertisement pages 172 and 173.
Circle A11 on postcard.

AIRCOOLERS—Booklet. American Locomotive Co. See advertisement page 25.
Circle A12 on postcard.

INSULATION MATERIALS—Catalog. Armstrong Cork Co. See advertisement page 61.
Circle B3 on postcard.

STEAM TRAP—Booklet. Armstrong Machine Works. See advertisement page 5.
Circle B4 on postcard.

PNEUMATIC PRESSURE TRANSLATOR—Literature. Askania Regulator Co. See advertisement page 179.
Circle B6 on postcard.

PUMPS—Catalog M. Aurora Pump Co. See advertisement page 304.
Circle B7 on postcard.

TUBING—Alloy letter No. 265. The Babcock & Wilcox Tube Co. See advertisement pages 2b and 29.
Circle B9 on postcard.

ELECTRONIC INSTRUMENTS—Bulletin 231. Bailey Meter Co. See advertisement page 216.
Circle B11 on postcard.

CORROSION PROTECTION—Literature. The Barrett Division. See advertisement page 302.
Circle C1 on postcard.

PIPE AND BOLT MACHINE—Bulletin E. Beaver Pipe Tools. See advertisement page 331.
Circle C2 on postcard.

PORTABLE METER—Data. Beckman Instruments, Inc. See advertisement page 244.
Circle C3 on postcard.

WATER TREATING SERVICE—Literature. The Bird-Archer Co. See advertisement page 260.
Circle C6 on postcard.

PLANT CONSTRUCTION—Catalog. Black, Sivalls & Bryson, Inc. See advertisement page 18.
Circle C7 on postcard.

TUBLAR HEATERS—Data. Black, Sivalls & Bryson, Inc. See advertisement page 197.
Circle C8 on postcard.

GRATINGS—Bulletin 2365. Blaw-Knox Co. See advertisement page 326.
Circle C11 on postcard.

CONTROLLER—Bulletin A120. The Bristol Co. See advertisement page 17.
Circle D1 on postcard.

HEAT EXCHANGERS—Bulletin 481. The Brown Fintube Co. See advertisement opposite page 97.
Circle D2 on postcard.

PUMPS—Bulletins. Byron Jackson Co. See advertisements pages 154-157.
Circle D4, D5, D6, D7 on postcard.

PLUG VALVES—Catalog. Cameron Iron Works, Inc. See advertisement page 305.
Circle D9 on postcard.

INSULATION DATA BOOKS. The Philip Carey Mfg. Co. See advertisement page 51.
Circle D10 on postcard.

CHECK VALVES—Bulletin 30. The Chapman Valve Mfg. Co. See advertisement page 35.
Circle D11 on postcard.

TOWER ESCAPE DEVICE—Folder. Charlie's Machine Works. See advertisement page 329.
Circle D12 on postcard.

HEAT EXCHANGER TUBES—Data booklet. Chase Brass & Copper Co. See advertisement page 250.
Circle E1 on postcard.

SLIDE VALVE OPERATOR—Bulletin PR. Conoflow Corp. See advertisement page 283.
Circle E5 on postcard.

STEAM JET EVACTOR—Data. Croll-Reynolds Co. See advertisement page 291.
Circle E9 on postcard.

TANK SUCTION HEATERS—Literature. Davis Engineering Corp. See advertisement page 299.
Circle E10 on postcard.

CATALYST, CHEMICALS—Literature. The Davison Chemical Corp. See advertisement pages 20 and 21.
Circle E11 on postcard.

STEAM TURBINES—Catalog 400. Dean Hill Pump Co. See advertisement page 298.
Circle F1 on postcard.

SULFUR DETERMINATOR—Data. Harry W. Dietert Co. See advertisement page 269.
Circle F3 on postcard.

PETROLEUM CHEMICALS—Free Movies and Literature. E. I. du Pont de Nemours & Co. See advertisement insert 296-297.
Circle F5 on postcard.

PACKING—Bulletin DMPR. Durametallic Corp. See advertisement page 306.
Circle F7 on postcard.

SIDE ENTERING MIXERS—Catalog 600. Eastern Industries, Inc. See advertisement page 304.
Circle F9 on postcard.

ADSORBENTS AND CATALYSTS—Literature. Filtrol Corp. See advertisement opposite 289.
Circle G3 on postcard.

GASKETS—Data. Flexitallic Gasket Co. See advertisement page 90.
Circle G4 on postcard.

ABSORBENTS—Bulletins. Floridin Co. See advertisement page 291.
Circle G6 on postcard.

TECHNICAL SERVICE BULLETIN. General Chemical division. See advertisement page 232.
Circle G11 on postcard.

MECHANICAL-DRIVE TURBINES—Bulletin GEA-4955. General Electric Co. See advertisement pages 80 and 81.
Circle G12 on postcard.

HEAT EXCHANGERS—Bulletin. The Griscom-Russell Co. See advertisement pages 162 and 163.
Circle H6 on postcard.

OXYGEN RECORDER—Literature. The Hays Corp. See advertisement page 170.
Circle H11 on postcard.

TUBE EXPANDERS—Bulletin 80-130. A. L. Henderer's Sons. See advertisement page 306.
Circle H12 on postcard.

CORROSION PROTECTION—Data. Houghton Laboratories, Inc. See advertisement page 327.
Circle J1 on postcard.

PROTECTIVE COATINGS—Catalog. Insul-Mastic Corporation of America. See advertisement page 236.
Circle J4 on postcard.

MIXERS—Catalog. International Engineering, Inc. See advertisement page 252.
Circle J5 on postcard.

ALLOYS—Literature. The International Nickel Co. See advertisement page 73.
Circle J7 on postcard.

WIRE MESH—Literature. The C. O. Jelliff Mfg. Corp. See advertisement page 314.
Circle J8 on postcard.

GAGE ILLUMINATORS—Data. Jerguson Gage & Valve Co. See advertisement page 324.
Circle J9 on postcard.

INSULATING FIRE BRICK—Data. Johns-Manville Co. See advertisement page 74.
Circle J10 on postcard.

HEAT INSULATION—Catalog. Kaylo Div. Owens-Illinois Glass Co. See advertisement page 52.
Circle J11 on postcard.

HEAT INSULATION—Data. Keasbey & Mattison Co. See advertisement page 23.
Circle J12 on postcard.

GAS GENERATORS—Bulletin 1-10. The C. M. Kemp Mfg. Co. See advertisement page 309.
Circle K2 on postcard.

STEEL GRATINGS—Catalog. Kerlow Steel Flooring Co. See advertisement page 331.
Circle K3 on postcard.

NEEDLE VALVES—Bulletin 49-N. Kerotest Manufacturing Co. See advertisement page 327.
Circle K4 on postcard.

CONTROL VALVES—Bulletin 810. Kieley & Mueller, Inc. See advertisement page 308.
Circle K5 on postcard.

EXPLOSION PROOF LIGHTS—Literature. Killark Electric Mfg. Co. See advertisement page 331.
Circle K6 on postcard.

ROTATING PLUNGER PUMP—Bulletin L51. Kinney Manufacturing Co. See advertisement page 273.
Circle K7 on postcard.

CORROSION-PROOF EQUIPMENT—Bulletin 3-U. Maurice A. Knight. See advertisement page 198.
Circle K8 on postcard.

BUBBLE TRAYS—Literature. The Koch Engineering Co. See advertisement pages 176 and 177.
Circle K9 on postcard.

WATER WELL SYSTEMS—Catalogs. Layne & Bowler, Inc. See advertisement page 280.
Circle K11 on postcard.

CALIBRATING TANKS—Bulletin. Warner Lewis Co. See advertisement page 329.
Circle L1 on postcard.

STEEL PLATES AND SHAPES—Literature. Lukens Steel Co. See advertisement page 68.
Circle L2 on postcard.

VALVES—Circular 561. The Lunkenheimer Co. See advertisement page 332.
Circle L3 on postcard.

WATER COOLING TOWER—Bulletin ML-51. The Marley Co. See advertisement page 54.
Circle L8 on postcard.

SPEEDRANGERS—Data Book 7525. The Master Electric Co. See advertisement page 6.
Circle L10 on postcard.

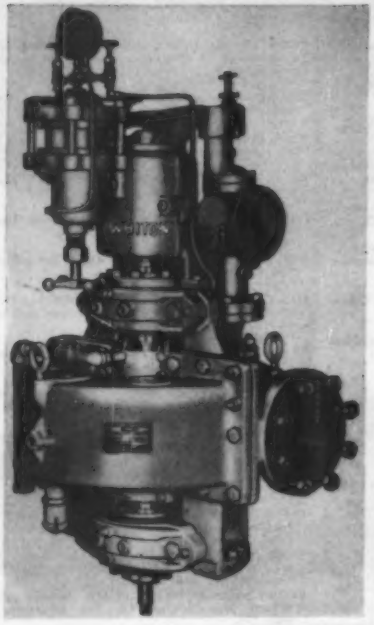
MIST ELIMINATORS—Bulletin. Metal Textile Corp. See advertisement page 316.
Circle M1 on postcard.

PROPORTIONING PUMP—Literature. Milton Roy Co. See advertisement page 153.
Circle M3 on postcard.

CONTROLLERS—Literature. Minneapolis-Honeywell Regulator Co. See advertisement pages 12 and 13.
Circle M4 on postcard.

Whiton SOLID STEEL ROTOR

STEAM TURBINES



VERTICAL TURBINE DRIVES

for

ECONOMICAL

and

DEPENDABLE

Operation of

- PUMPS
- FANS
- COMPRESSORS

Whiton Vertical Turbines, available in various types and frame sizes up to 600 Horsepower.

Solid Steel Rotor design assures high efficiency for low-speed, direct drive.

Where dependable vertical drive is required . . . use Whiton.

Send for complete information.

Whiton SINCE 1856 WHITON MACHINE CO.

NEW LONDON 14, CONN., U.S.A.

Catalogues—Bulletins

DIFFERENTIAL CONVERTER—Catalog 2281. Minneapolis-Honeywell Regulator Co. See advertisement page 264.
Circle M5 on postcard.

PIPE WELDING FITTINGS—Catalog 48. Mixing Equipment Co. See advertisement page 258.
Circle M6 on postcard.

LUBE OIL ADDITIVES—Data. Monsanto Chemical Co. See advertisement page 43.
Circle M7 on postcard.

STEAM TURBINES—Bulletin. Murray Iron Works Co. See advertisement page 292.
Circle M9 on postcard.

OIL AND GAS BURNING EQUIPMENT—Bulletin 21. National Airoil Burner Co. See advertisement page 280.
Circle M10 on postcard.

CATALYST—Catalog. National Aluminate Corp. See advertisement page 8.
Circle M11 on postcard.

STEAM TRAPS—Catalog 751. W. H. Nicholson & Co. See advertisement page 53.
Circle N2 on postcard.

CLEANING AND DESCALING METHODS—Literature. Oakite Products, Inc. See advertisement page 282.
Circle N4 on postcard.

CENTRIFUGAL PUMPS—Bulletins. Pacific Pumps, Inc. See advertisement page 312.
Circle N8 on postcard.

DIAL THERMOMETERS—Bulletin 51-129. Palmer Thermometers, Inc. See advertisement page 50.
Circle N10 on postcard.

GREASE KETTLES—Literature. The Patterson Foundry & Machine Co. See advertisement page fourth cover.
Circle N12 on postcard.

FLOATING SHANK GAGES—Literature. Penberthy Injector Co. See advertisement page 135.
Circle P1 on postcard.

AUTOMATIC VALVE CONTROLS—Catalog L-50. Philadelphia Gear Works, Inc. See advertisement page 266.
Circle P3 on postcard.

PERCO PROCESS—Literature. Phillips Petroleum Co. See advertisement page 240.
Circle P6 on postcard.

GAS DRYING SYSTEMS—Data. Pittsburgh Locktrodryer Corp. See advertisement page 68.
Circle P7 on postcard.

COOLING TOWERS—Bulletins. J. F. Pritchard & Co. See advertisement page 288.
Circle P12 on postcard.

BLENDER—Literature. %Proportioneers, Inc%. See advertisement second cover.
Circle Q1 on postcard.

BUTTERFLY VALVES—Data. R-S Products Corp. See advertisement page 42.
Circle Q3 on postcard.

VALVES—Catalog. Reading-Pratt & Cady Division. See advertisement page 313.
Circle Q4 on postcard.

PLANT CONSTRUCTION—Data. The Refinery Engineering Co. See advertisement pages 188 and 189.
Circle Q5 on postcard.

SCIENTIFIC INSTRUMENTS—Bulletin 50. Refinery Supply Co. See advertisement page 296.
Circle Q6 on postcard.

ALLOY STEELS—Data. Republic Steel Corp. See advertisement page 48.
Circle Q7 on postcard.

CONDENSER TUBES—Data. Revere Copper and Brass Inc. See advertisement page 133.
Circle Q8 on postcard.

BUTTERFLY VALVES—Data. W. S. Rockwell Co. See advertisement page 328.
Circle Q12 on postcard.

BALL VALVES—Folder V-4. Rockwood Sprinkler Co. See advertisement page 16.
Circle R1 on postcard.

CONDENSER TUBE BOOKLET. Scovill Manufacturing Co. See advertisement page 47.
Circle R3 on postcard.

ROTARY SHAFT SEALS—Data. Sealol Corp. See advertisement page 277.
Circle R4 on postcard.

AIR OR GAS CONDITIONING EQUIPMENT—Bulletins. Selas Corporation of America. See advertisement page 169.
Circle R5 on postcard.

EXCHANGER TUBE TESTER—Data. Shell Development Co. See advertisement page 67.
Circle R7 on postcard.

PUMP VALVES—Catalog. Sims Pump Valve Co. See advertisement page 293.
Circle R8 on postcard.

SULFUR and CARBON *Analyses* in PETROLEUM PRODUCTS

The sulfur content of oils, waxes and greases is an important measure of the value and quality of the product.

Whether the desired sulfur content be high or low, it is necessary to know exactly what amount is present.

The combustion method offers a rapid and sure means of determining sulfur in the wide range of percentages and materials encountered in the oil and grease field.

The Dietert-Detroit Sulfur Determinator embodies the correct principles of the combustion method in a simple, rugged and convenient form. Complete analysis can be made in less than five minutes.

Carbon determinations on organic compounds are being made in as little as two minutes with the Dietert-Detroit No. 3003 Carbon Determinator.

This method can be applied to any petroleum product. One example of the usefulness of this method is the analysis of cracking catalyst for carbon content.

Leading oil companies* are taking advantage of these versatile, time-saving determinators. Write to Dept. P-4 for detailed information on how you can apply rapid carbon and sulfur analysis to your problems.

*Two typical users— { THE SHELL OIL COMPANY / THE PURE OIL COMPANY

CONTROL EQUIPMENT

HARRY W. DIETERT COMPANY

9330 ROSELAWN • DETROIT 4, MICH.

Catalogues—Bulletins

HEAT EXCHANGERS & PRESSURE VESSELS—Bulletins V-52 and V-53. A. O. Smith Corp. See advertisement page 11.
Circle R9 on postcard.

SAFETY GRATING—Data. A. O. Smith Corp. See advertisement page 269.
Circle R10 on postcard.

ACID RESISTANT CLOTHING—Bulletin 526. Standard Safety Equipment Co. See advertisement page 310.
Circle S1 on postcard.

STEAM TRAPS—Catalog 68-R. Strong, Carlisle & Hammond Co. See advertisement page 281.
Circle S3 on postcard.

DIRECT FIRED HEATERS—Bulletin V-45. Struthers Wells Corp. See advertisement page 31.
Circle S4 on postcard.

WELDING FITTINGS & FLANGES—Data sheets. Taylor Forge & Pipe Works. See advertisement page 231.
Circle S7 on postcard.

CONTROL INSTRUMENTS—Bulletin 98097. Taylor Instrument Companies. See advertisement pages 210 and 211.
Circle S8 on postcard.

GASOLINE ADDITIVES—Data. Tennessee Eastman Co. See advertisement page 22.
Circle S9 on postcard.

STEAM TURBINES—Bulletin S-116. The Terry Steam Turbine Co. See advertisement page 59.
Circle S10 on postcard.

PIPE INSULATIONS—Catalog 76-109. Union Asbestos & Rubber Co. See advertisement page 56.
Circle T3 on postcard.

FLAME ARRESTERS—Literature. The Vapor Recovery System Co. See advertisement page 93.
Circle T6 on postcard.

ALLOY STUDS AND BOLTS—Catalog. Victor Products Corp. See advertisement page 328.
Circle T7 on postcard.

FILM TYPE EXCHANGERS—Bulletin HE-7. Henry Vogt Machine Co. See advertisement page 32.
Circle T9 on postcard.

HARD-FACING ALLOYS—Literature. Wall-Colmonoy Corp. See advertisement page 284.
Circle T10 on postcard.

COOLING WATER TREATERS—Literature. Wallace & Tiernan Products, Inc. See advertisement page 295.
Circle T11 on postcard.

PLUG VALVES—Literature. Walworth Co. See advertisement page 65.
Circle T12 on postcard.

COOLING TOWER—Literature. Water Cooling Equipment Co. See advertisement page 276.
Circle U2 on postcard.

PIPE FITTINGS—Bulletin A3-50. Watson-Stillman Co. See advertisement page 253.
Circle U3 on postcard.

DIAL THERMOMETERS—Literature. Weston Electrical Instrument Corp. See advertisement page 254.
Circle U4 on postcard.

COOLING SYSTEMS—Booklet. C. H. Wheeler Mfg. Co. See advertisement page 219.
Circle U6 on postcard.

PROCESS EQUIPMENT—Data. The Whitlock Manufacturing Co. See advertisement page 272.
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STEAM TURBINES—Literature. Whiton Machine Co. See advertisement page 268.
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Detroit's answer was to install cathodic protection, using graphite ground anodes to protect the metal piping. Sixty-eight 4" x 40" "National" graphite anodes were placed under each garage. Two anodes were placed in each hole made through the concrete floor, the holes being spaced 57' to 102' apart. Cost of this installation, which is providing ample protection, was only $15,000.

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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

Tonnage of the oil industry's tanker fleet has been nearly doubled since 1939. With bigger and faster tankers, the fleet now exceeds 578 ships and 8,639,800 deadweight tons.

Fundamental Physical and Chemical Data

Volumetric and Phase Behavior of Propene-Propane System. H. H. REAMER AND B. H. SAGE. *Ind. Eng. Chem.*, **43** (1951), pp. 1628-34.

The compositions of the coexisting phases of the system propene-propane were studied at five temperatures between 10° and 190° F. Equilibrium ratios were established and the data were smoothed by use of the quotient of the actual equilibrium ratio and that predicted from Raoult's law. At the lower pressures uncertainty in measurement of pressure limited the accuracy of the results, whereas at the higher temperatures the measurements of composition were the primary source of error. The molal volumes of two mixtures were determined at seven temperatures between 10° and 400° F. for pressures from 200 to 10,000 pounds per square inch. The data indicate for propane progressively smaller deviations from Raoult's law as the temperature is decreased, but a minimum deviation for propene is shown at approximately 100° F. The maximum deviation was for propane at 190° F. and at those compositions near pure propene. Only small deviations from an additive volume relationship were found throughout the entire range of pressures and temperatures. The maximum deviation near the critical states of the system was 1.7 percent for a mole fraction of 0.6289 propane at 600 pounds per square inch and 220° F. The data are presented in detail in tabular and graphical form and a bibliography of 16 references is included.

An Improved Type of Vapour-Liquid Equilibrium Still. JOHN D. THORNTON. *Journal of Applied Chem.*, **1** (1951), pp. 237-9.

The author briefly reviews the various types of stills that have employed to date in determining vapour-liquid equilibria and points out the disadvantages of the various apparatus. The apparatus described in the paper was designed to minimize the defects of the previously used apparatus. The main features are a Cottrell pump with a separate liquid-phase trap and a vacuum-jacketed vapour trap. Systems can be investigated that give two-phase vapour condensates. Provision is made for accurate measurements of true equilibrium temperature under well-defined pressure conditions, the effect of hydrostatic head on temperature and phase compositions being entirely eliminated. The apparatus is described in some detail and a diagram, as well as a photograph, are presented. A bibliography of nine references is included.

Equilibrium Flash Vaporization of Petroleum Crude Oils or Fractions, Method and Apparatus for Determination. DONALD F. OTHMER, E. H. TEN EYCK, AND STANLEY TOLIN. *Ind. Eng. Chem.*, **43** (1951), pp. 1607-13.

In the design of equipment for the separation of multicomponent mixtures it is necessary to have data on vapor-liquid equilibrium relations at points representing different amounts vaporized. These data are ordinarily referred to as "equilibrium flash vaporization curve." The authors present a new apparatus and procedure for the study of these vapor-liquid phase relations. This is a recirculating still similar to those that have been used in the study of binary and ternary systems. Data are presented at atmospheric and subatmospheric pressures for equilibrium conditions and with measurement of entrainment and pressure drop. A number of petroleum fractions and stocks have been studied.

Viscosity Behavior of Gases. L. A. BROMLEY AND C. R. WILKE. *Ind. Eng. Chem.*, **43** (1951), pp. 1641-8.

The authors note that a need has existed for a review of methods for prediction of gas viscosity including the effects of pressure, temperature, and composition, and for the presentation of these methods in convenient form for engineering use. The article includes charts for predicting the effect of temperature at low pressures based on the refined kinetic theory of Chapman and Cowling as developed by Hirschfelder, Bird, and Spotz. The required constants are tabulated for the common gases and methods of estimation of unknown values are presented. Detailed tables of temperature functions are given for use when high accuracy is necessary. Curves based on the work of Uyehara and Watson were constructed to estimate the effects of pressure and temperature on viscosity of gases at high pressures. Constants for gas mixture viscosity equations are given in graphical form for simplifying the calculation of viscosity in multicomponent systems. The methods of predicting gas viscosity are reviewed and compared. The authors are of the opinion that the charts and simplified equations given will materially reduce the numerical calculations ordinarily required, and yet yield results that are sufficiently accurate for most engineering purposes.

These abstracts from the current literature of science and technology (not including trade journals easily available) were prepared by Drs. Leslie and Coats of The Leslie Laboratories, Traver Road, Ann Arbor, Mich., which will supply, at cost, photostatic copies of original articles. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also may be had by arrangement with the laboratories.

Thermal Analysis of the System Sodium Stearate-Cetane. F. H. STROSS AND S. T. ABRAMS. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 2825-8.

Literature data on the phase behavior of anhydrous sodium stearate in hydrocarbons do not give a clear or consistent picture, probably because of the presence of traces of water in the system studied. The authors obtained data on the system sodium stearate and cetane in a specially designed calorimeter capable of measuring small temperature changes that accompany phase changes. Supplementary observations were made using polarized light. The phase diagram constructed indicates that there is no appreciable interaction between soap and cetane below about 140° C. At higher temperatures the transition temperatures of the soap are depressed by addition of the solvent. This depression was found to be constant over most of the temperature range studied. Approximate measurements of the latent heats involved were made and the total molal latent heats for sodium stearate and summed partial molal latent heats for the soap in the solvent were found to be approximately 10,700 g. calories.

Mixed Hydrocarbon Solvents for Fatty Acids and Their Triglycerides. RICHARD BOGASH AND A. NORMAN HISCOM. *Chem. Eng. Progress*, **47** (1951), pp. 347-53.

The solubility of fatty acids and their

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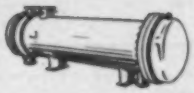

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triglycerides in solutions of methane and propane were studied and compared with the relationships in pure propane. The addition of methane effectively lowers the critical solution temperature for a given solute. Data are presented for the system stearic acid-propane-methane at 85.4° C. and 71.2° C. and for the system trimyristin-propane-methane at 69.6° C. and 61° C. The corresponding critical solution temperature for the propane binary solution is 91.4° C. for stearic acid and 79.4° C. for trimyristin. The authors present evidence of the importance of solvent density and compare the results with predictions from a generalized solubility equation of Hildebrand. The use of methane increases the versatility of propane as a selective solvent. A bibliography of 16 references is included.

Chemical Composition and Reactions

Catalytic Esterification of Olefins with Organic Acids. R. D. Morin and A. E. Bearse. *Ind. Eng. Chem.*, **43** (1951), pp. 1596-1600.

The production of esters by the catalytic esterification of olefins with organic acids offers a possible method of converting by-product refinery olefins into more useful and valuable products. The object of the work done was to find a suitable active and effective catalyst. Boron fluoride and hydrogen fluoride in admixture is a particularly effective catalyst in promoting esterification of olefins with organic acids. Isopropyl acetate was prepared from propylene and acetic acid in 80 percent yield. Catalyst recovery and reactor corrosion were studied. Formation of ether is also promoted by the mixed fluoride catalyst. The corrosion problem was largely overcome by the use of a pressure reactor constructed of No. 316 stainless steel, the corrosion of which was found not to be serious under the required conditions. A bibliography of 28 references is included.

Addition of Hydrogen Sulphide to Iso-Pentene with Aluminum Chloride as Catalyst. A. J. van Riemsdijk, J. van Steenis, and H. I. Waterman. *Jour. Inst. of Petroleum*, **37** (1951), pp. 265-9.

The investigation was concerned with the addition of hydrogen sulphide to olefins under the influence of aluminum chloride or solutions of aluminum chloride in mercaptan and/or thioether. The greater part of the work was done with 2-methylbutene-2. The tertiary-amyl mercaptan was formed. This, however, added to the olefin, giving di-*tert*-amyl thioether. Aluminum chloride compounds with mercaptan or with the thioether are more suitable catalysts for the addition reaction than pure aluminum chloride. Under the reaction conditions, *tert*-amyl mercaptan and *tert*-amylthioether can be converted each into the other, in the presence of catalyst and H_2S. An equilibrium is indicated. Preliminary experiments with other olefins yielded results analogous to those obtained in this work. The yield was found to be small for primary and secondary olefins, but *tert*-olefins reacted rapidly.

Investigation Into the Olefinic Com-

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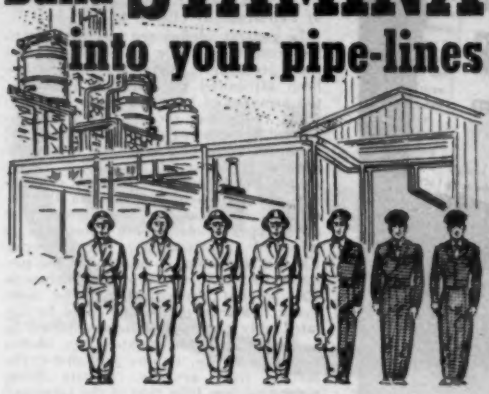

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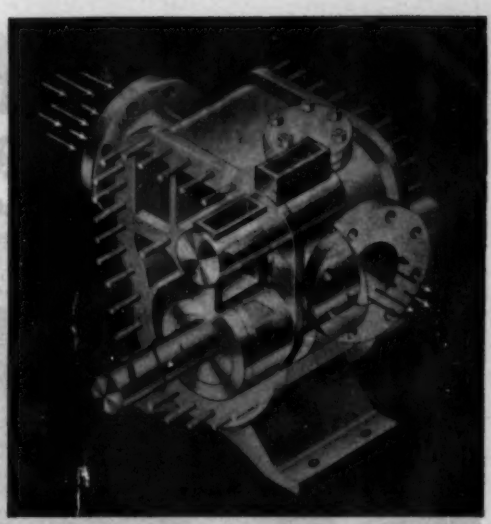

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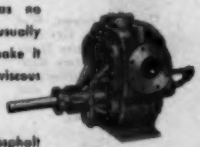

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Science and Technology

ponents of a Pennsylvanian Crude Oil. F. A. HAAK AND K. VAN NES. *Jour. Inst. of Petroleum*, **37** (1951), pp. 245-54.

In general, olefins are assumed not to be present in crude mineral oils, and their presence in distillate fractions has been attributed to cracking. However, the presence of trans-olefins in Pennsylvania crude has recently been demonstrated by spectroscopy work conducted in an effort to find out more about the general structure of the olefins occurring in Pennsylvania crude oil. Comparison of spectroscopic data with the results of chemical analyses showed that other types of olefins, not detectable by infra-red spectroscopy, are present. Careful fractionation resulted in the isolation of cyclic non-aromatic olefins in 100 percent concentration. The non-cyclic non-aromatic olefins could be isolated only partly, and were obtained as a 45 percent concentrate. The olefins consisted of di-, mono-, and non-cyclic olefins, their average cyclicity being somewhat less than that of the saturated part of the fraction.

Polymerization of Isobutene by Boron Trifluoride. ALWYN G. EVANS. *Journal of Applied Chem.*, **1** (1951), pp. 240-2.

The polymerization of isobutene by BF_3 requires a co-catalyst. The true catalyst for the polymerization is the complex of the BF_3 and the co-catalyst. In polymerizing isobutene a low temperature is needed for production of a high molecular weight polymer. At temperatures such as —100° C., the BF_3-catalysed reaction is practically instantaneous. However, if the olefin and catalyst are sufficiently pure, the reaction does not occur, even at low temperature. Water, *tertiary*-butyl alcohol and acetic acid have been found to act as co-catalysts for the BF_3-isobutene reaction at room temperature.

Products: Properties, Utilization and Analysis

Gum Formation in Shale-Oil Naphtha. G. U. DINNEEN AND W. D. BICKEL. *Ind. Eng. Chem.*, **43** (1951), pp. 1604-7.

Shale-oil naphtha when first distilled ranges from pale yellow to amber color, but, if exposed to room conditions, it will become dark purple and start to deposit gum on the sides of the container within a short time. Large quantities of gum are produced within hours or days. The work reported in the paper was undertaken to establish the factors responsible for this instability. Gums from shale-oil naphtha contain about 8 percent nitrogen. In this they differ from the gums from petroleum naphthas. The nitrogen comes from both pyrrole and pyridine-type compounds in the naphtha. Oxidation is more important than light or heat in the formation of gum from shale-oil naphtha. Upon exposure to accelerated oxidizing conditions, the rate of gum formation is very rapid at first, but decreases sharply after about one hour.

Notes on the Lubricating Effect of Colloidal Graphite. E. A. SMITH. *Jour. Inst. of Petroleum*, **37** (1951), pp. 255-8.

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evaluation of the lubricating action of graphite in the form of dry films and as a solid colloidal dispersion in oil. Measurements made using natural and electric-furnace graphite indicated no noticeable differences between the two products. It was found that colloidal graphite minimizes metal pickup between sliding metal surfaces. The coefficient of friction of graphite on graphite was found to be less than unlubricated metal on metal and less than mineral oil under boundary conditions. Friction values of a graphited surface were found to be lower in the presence of an oil than either the graphite film alone or for the oil alone. Apparently this is caused by the higher adsorption of the oil on a graphited surface than on a metal surface. It is important that the particle size of the graphite be small if the rubbing speeds are high. Flake graphite failed to lubricate at any but the lowest speeds because it is not absorbed on the metal. Temperature has little effect on the coefficient of a graphited oil surface. When the temperature increases the coefficient of friction increases if plain oil is the lubricant. The maximum action of colloidal graphite in an oil is obtained when an adsorbed graphoid surface has been formed on the rubbing faces of the mechanical equipment.

The Role of Peroxides in the Corrosion of Lead by Lubricating Oils. B. S. WILSON AND F. H. GARNER. *Jour. Inst. of Petroleum*, **37** (1951), pp. 225-38.

The mechanism through which soft bearing metals are corroded by lubricating oils undergoing oxidation in an engine is not well understood. It is known that acids are produced and, in some oils, compounds of a peroxide nature are formed, possibly as intermediate compounds that exist for only a short time. The present work was concerned with the investigation of such peroxide compounds, their formation and relation to the degree of oxidation, and their effect on the rate of corrosion of lead. Both white oil and engine oil were studied. With white oils the results show a similarity between the shapes of the curves obtained from peroxide content and rate of corrosion, but dissimilarity between these and the curves for acidity. For engine oils the curves for peroxide content and rate of corrosion show some similarity during continuous-oxidation experiments, but there was no similarity between either of these curves and the curves for acidity. After oxidizing the oils in the absence of lead, for the period, the oils were highly corrosive to lead, but this heavy rate of attack decreased quickly if they remained in contact with the metal. For the oils studied the peroxides generated were only capable of producing slight corrosion in the absence of air. The work shows the importance of peroxide and of atmospheric oxygen in the mechanism of corrosion, thus supporting the theory that the metal is oxidized before reacting with acid.

Recovery of Inorganic Ash from Petroleum Oils. Radiochemical Evaluation. L. O. MORGAN AND S. E. TURNER. *Analytical Chem.*, **23** (1951), pp. 978-9.

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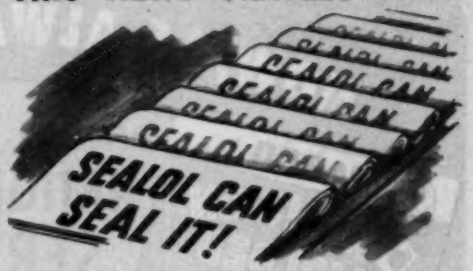

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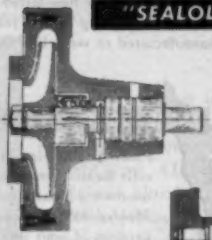

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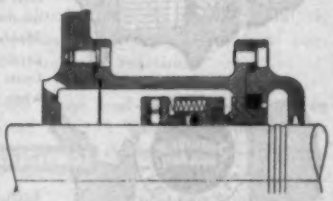

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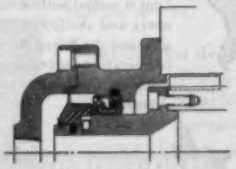

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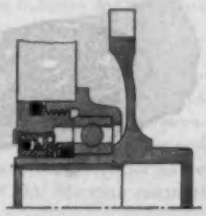

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Science and Technology

information concerning the amounts of inorganic contaminants in the feed stocks. The most widely used method of determining inorganic ash is the standard ashing procedure of the A.S.T.M. However, inorganic components can be lost by volatilization, or through mechanical loss during combustion. The study reported in the paper was made in an attempt to evaluate the significance of the possible errors. Radiochemical techniques were used to trace the metallic components of contaminants added to several typical oils and handled in the standard combustion and ignition processes. Practically complete recovery of iron, calcium, and sodium tracers was obtained when they were added to the oils as naphthenes, salicylates, and inorganic salts, if the combustion was effected at less than 550° C. It was found that traces of water or other sources of surface turbulence during combustion led to the losses.

Mineral Oil as a Wool Lubricant; Emulsification of Blends of Mineral Oil and Wool-Wax Alcohols. E. V. Truter. *Jour. of Applied Chem.*, 1 (1951), pp. 254-7.

The difficulty of removing mineral oil from wool by emulsification with soap and soda is caused by the high adhesion between wool and mineral oil, which is aggravated by the high interfacial tension between mineral oil and water. A small percentage of oleyl alcohol added to the mineral oil increases the efficiency of scouring, the best results being obtained with a blend containing 7 percent of oleyl alcohol. Wool fabric oiled with 5 percent of this blend retained less than one-half percent of oil after scouring, whereas with mineral oil alone the residual oil was 2.1 percent. Wool wax contains alcohols that, when mixed with mineral oil, give blends that are stable and easily removed from wool. The flash

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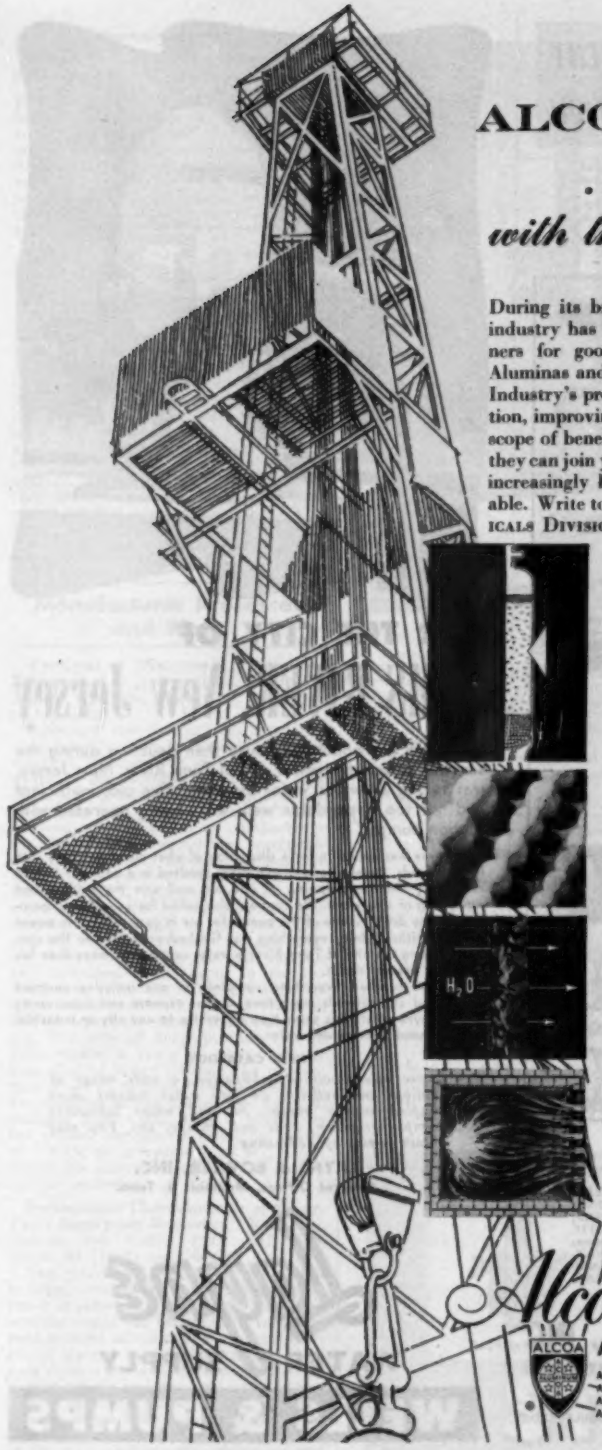

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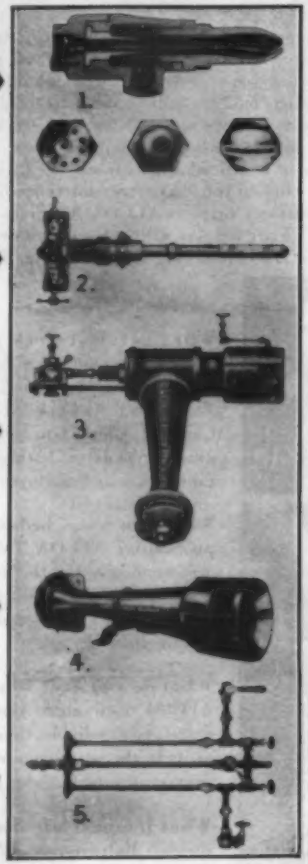

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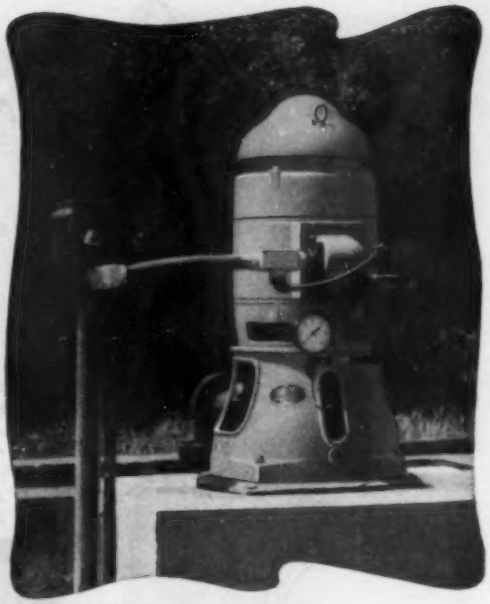

FOR THE CITY OF TOMS RIVER, New Jersey

With her population more than doubling during the summer season, the resort city of Toms River, New Jersey, was facing a serious water shortage. Five old, inefficient and not too dependable wells were being operated with suction pumps.

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points are well above the necessary minimum laid down by the fire insurance companies, that is 340° F. There is no tendency for spontaneous oxidation, nor do the blends become discolored if exposed to strong light for considerable periods of time. The isolation of these alcohols from several sources is described.

Infrared Analysis of cis- and trans-Decahydronaphthalene. JAY SEIDMAN. *Analytical Chem.*, **23** (1951), pp. 559-63.

The possibility of utilizing an infrared spectrometer for distinguishing isomers has long been recognized. The author applied this method to the analysis of a mixture of cis- and trans-decahydronaphthalene. The spectra of the two hydrocarbons are presented. A series of nine blends was made with spectroscopically pure samples of the hydrocarbons and the weight percent compared with those determined by spectrographic analysis. A solution containing a mixture of cis- and trans-Decalin with other noninterfering components can be analyzed so as to give the percentage of Decalin isomers present as the sum of the two.

Manufacture: Processes and Plant

Pyrolysis of Mixtures of Ethane and Ethane-d_6. LEO A. WALL AND WALTER J. MOORE. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 2840-4.

Although the thermal decomposition of ethane has been studied by many workers, it cannot be said that the reaction is satisfactorily understood. One important problem concerns the extent to which the reaction proceeds via a free-radical mechanism as compared to the extent via a molecular rearrangement. The authors studied this problem through thermally decomposing mixtures C_2H_6 and C_2D_6 followed by mass-spectrometric analyses of the products. The reaction was studied in the range 510° and 610° C. The extensive isotopic mixing observed indicates that free radicals and hydrogen atoms occur in the decomposing mixture. The presence of nitric oxide inhibits the rate of reaction, and decreases the extent of isotopic mixing. The over-all decomposition rate of light ethane is about 50 percent faster than that of heavy ethane. The production of $-CD_3$ radicals from C_2D_6 is about five times as fast as production of $-CH_3$ radicals from C_2H_6. This is caused by the greater density of rotational states of $-CD_3$ as compared to CH_3, which lowers the activation entropy for heavy-radical formation.

Performance Characteristics of Spray-Type Absorption Equipment. ROBERT L. PIGFORD AND CYRUS PYLE. *Ind. Eng. Chem.*, **43** (1951), pp. 1649-62.

Absorption or distillation equipment in which contact between a liquid and a vapor is achieved by spraying the liquid into the vapor has been known for some time to have advantages over plate towers or packed towers, in that the pressure drop is low and the tower construction is simple and not subject to corrosion. The object of the work reported was to obtain information on the characteristics of commercial spray nozzles of the type used in spray absorbers and

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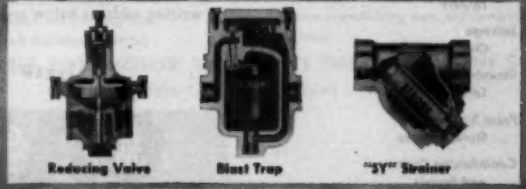

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on the rates of mass transfer and the fluid velocities that can be obtained in spray chambers. Flow characteristics and drop-size data are reported for several commercial water spray nozzles. The rates of absorption of oxygen or ammonia, simultaneous transfer of heat and water vapor, and desorption of oxygen into air from water sprays are given for spray towers twelve inches square and 31.5 inches in diameter, and of two different heights. The rate of mass or heat transfer is most rapid near the spray nozzle, because of formation of fresh liquid surface and the collection of spray by the chamber walls. Fewer transfer units per unit of height are obtained in a tall chamber than in a short one. The number of transfer units is proportional to the liquid rate and is increased by the use of a finer spray. Interference from adjacent spray nozzles reduces the number of transfer units. The results, in general, indicate that spray type equipment can be nearly as efficient as packed towers, but is limited to applications that require only a few transfer units.

Principles of Reactor Design. Homogeneous Reactions. J. R. CADDELL AND D. M. HURT. *Chem. Eng. Progress*, **47** (1951), pp. 333-8.

The rational design of chemical reactors is one of the most challenging problems in the field of chemical engineering. For a generally useful development of reactor design principles, the classification of reactors on the basis of number and type of reacting phases is more satisfactory than the earlier unit process concept. The authors have found it convenient to employ the number-of-reaction-units concept as a measure of reactor performance. This is a dimensionless number that includes the reaction rate constant of conventional rate equations. It is broadly analogous to the transfer unit concept used in diffusional rate processes. A simplified method is given for correlating kinetic data of homogeneous reactions in order to calculate optimum reaction conditions from a minimum number of experimental data, and applying such rate data in the design of homogeneous reaction equipment.

Mass Transfer. Laminar Flow of Gases Through Granular Beds. MERK HOBSON AND GEORGE THODOS. *Chem. Eng. Progress*, **47** (1951), pp. 370-5.

The kinetics of mass transfer as applied to gases in single phase stream line flow through granular beds was studied for several binary systems. These included the vaporization of water, n-butanol, toluene, n-octane, and dodecane from surfaces of spherical packings in gases, air, nitrogen, carbon dioxide, and hydrogen. The data were correlated on the basis of the "j" mass-transfer factor and the modified Reynolds number applicable to the flow of fluids through granular beds. A critical modified Reynolds number of 50 was found comparable to the Reynolds value 2100, above which laminar flow normally disappears in circular conduits, or pipes. An analysis of the results in conjunction with values previously reported suggests that this critical modified Reynolds value of 50 is applicable also to the mass-transfer correlation for granular beds.

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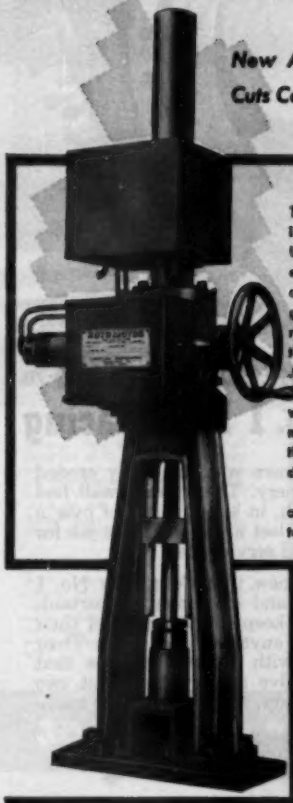
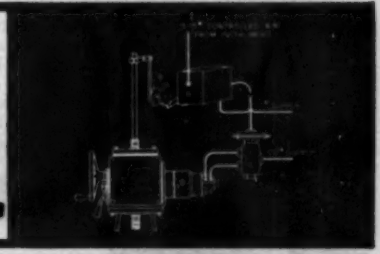


This new air-operated Rotomotor makes it unnecessary to invest the heavy capital required for hydraulic systems. Using ordinary plant air supply, the Rotomotor is more economical for operating slide valves in control of spent catalyst, regenerated catalyst, and back pressure of flue gas on stack valves. In addition to being dependable, rugged and compact, the Rotomotor is accurate and sensitive to instrument output pressure changes as small as .025 psi.

It is capable of handling thrust loads up to 60,000 lbs. with stem travels up to 36". It is inherently a self-locking mechanism because it operates through a gear drive and threaded stem. A continuously connected handwheel and declutching lever provide for manual operation if needed.

Rotomotors may be mounted on any catalyst slide valve of your choice at the manufacturer's plant and shipped to you as complete units ready for installation.



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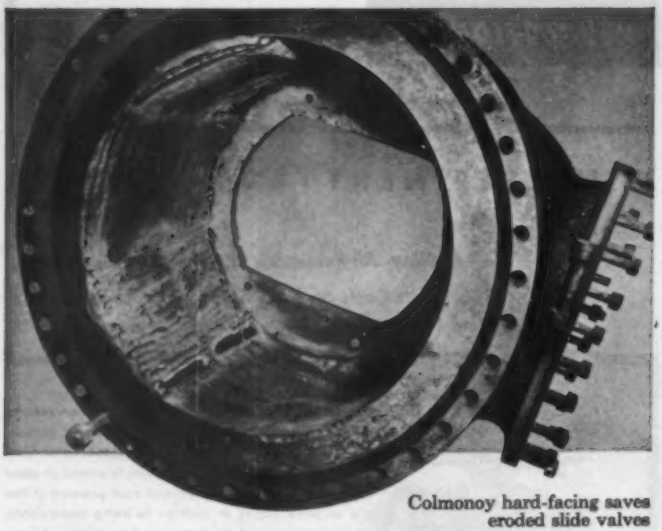

Colmonoy hard-facing saves eroded slide valves

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The catalyst slide valve shown here was the badly eroded property of a large western refinery. The interior wall had suffered severe erosion, to a depth, in some places, of over a quarter inch. The valve gate had lost 1/16" as well. The job for hard-facing: to reclaim and extend service life.

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The slide valve gate was preheated and then maintained at 350-400° F. COLMONOY No. 1 welds fast and easy.

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Science and Technology

The data indicate that below a modified Reynolds number of 50 the linear power distribution is applicable. For values of the modified Reynolds number above 150, a linear power distribution is equally applicable. The apparatus is described and the results are presented in considerable detail in tabular and graphical form.

Distillation in 2, 4 and 5.75-inch Diameter Packed Columns. A. C. HEINLEIN, R. E. MANNING, AND M. R. CANNON. *Chem. Eng. Progress*, **47** (1951), pp. 344-6.

Two types of protruded metal packings and 100 mesh, one-fourth-inch McMahon packing were studied in 2, 4, and 5.75-inch diameter columns. Data are given on efficiency, holdup and pressure drop over the operating range. Protruded metal packing with hole size B was found to be the most efficient, showing the lowest H.E.T.P. and the lowest pressure drop per plate. In order to determine the effect of the physical properties of the liquid on holdup and flooding velocity, several compounds were studied, namely, n-heptane, methylcyclohexane, benzene and ethylene dichloride. At any given vapor velocity, the holdup is greatest for the liquid of lowest density. The flooding velocity was highest for the densest liquid.

Continuous Flow Stirred Tank Reactor Systems. Agitation Requirements. R. W. MACDONALD AND EDGAR L. PIRET. *Chem. Eng. Progress*, **47** (1951), pp. 363-9.

When a chemical reaction is conducted in a continuous feed reactor with less than ideal mixing, the observed concentration of the effluent stream fluctuates both above and below the theoretical values, the magnitude of the fluctuations depends upon the reactor design, characteristics of the solution in the reactor, and probably upon the reaction rate. On increasing mixing intensity, the fluctuations decrease and the outlet concentration approaches the theoretical values closely. Mixing time in a reaction vessel was measured by introducing a small amount of dye solution into the feed stream of a continuous flow vessel. Also, the continuous hydrolysis of acetic anhydride, a first-order reaction, was effected in a single and also in a series of continuous reaction vessels. The time required for complete distribution through a continuous flow stirred reactor was measured as a function of agitator speed and feed stream rate. A critical agitator speed for mixing time was demonstrated. A tentative method of correlation is suggested, based on the energy input of the agitator plus that of the feed stream.

NPC Foresees Increased Petroleum Availability

Domestic availability of petroleum liquids will range from 7,789,000 to 8,838,000 barrels per day by 1955, National Petroleum Council predicted in a report by its Committee on Oil and Gas Availability to the Interior Department.

The figures cited for 1955 are 32 to 50 percent more than actual production of 5.9 million barrels per day in 1950.

The committee also predicted that availability elsewhere in the world outside Russia and her satellites by 1955

HUTCHINSON SERIES

"A System of Process Calculation for Light Hydrocarbons," a seven-part article that appeared in Petroleum Refiner commencing about a year ago, has been reprinted and copies are now available at 50 cents each. The reprint carries 44 pages and contains the full series. Address Librarian, Petroleum Refiner, Box 2608, Houston 1, Texas.

would be from 6,092,000 to 7,139,000 barrels per day, compared with an indicated productive capacity as of last January of 4,703,000 barrels per day.

NPC's report was predicated on the basis of conditions continuing to be favorable to petroleum development. Figures submitted by the committee, which is headed by L. F. McCollum, president of Continental Oil Company, were prepared by subcommittees under the leadership of Hines H. Baker, president of Humble Oil & Refining Company, and John R. Suman, vice president of Standard Oil Company (New Jersey).

Also forecast was a rise in natural gas availability in the U. S. from a range of 8.1 to 9.5 trillion cubic feet annually in 1951 to a range of 9.5 to 11.9 trillion cubic feet in 1955.

Ira Needles Named Head Of Goodrich of Canada

Ira G. Needles, vice president of The B. F. Goodrich Rubber Company of Canada Ltd., Kitchener, Ontario, since 1945 has been elected Company president, it is announced today by John L. Collyer, chairman of the board. Needles succeeds George W. Sawin, president since 1941 who resigned on June 30 for reasons of health.

Needles joined The B. F. Goodrich Company in 1916 and in 1925 became a member of B. F. Goodrich of Canada. He was elected vice president—sales in 1945. He has already assumed his new duties as president.

U.S. Rubber Elects Three To Executive Posts

Three men were elected to executive positions within the United States Rubber Company at a recent meeting. H. E. Humphreys, Jr., president of the company, was elected chairman of the board of directors, but will also continue as president. Humphreys joined U. S. Rubber as a vice president, director and member of the finance end of the executive committee in 1938.

John W. McGovern, vice president and general manager of the tire division was elected a member of the executive committee. McGovern started with the company as an accountant in 1920. Subsequent promotions named him general manager of the munitions division in 1941 and general manager of the tire division in 1943. He was elected a vice president in 1945 and a director in 1951.

Howard N. Hawkes, assistant general manager of the tire division was elected a vice president and will also take over the general managership of the tire division to succeed McGovern.

95% OF OIL RECOVERED FROM REFINERY WASTE WATER BY HARDINGE SEPARATORS

(Above) Part of the Hardinge installation of 21 rectangular clarifiers (oil separaters) which remove about 300 barrels of heavy emulsion per day from 35,000 g.p.m. of refinery waste water at two Ohio refineries. The storage tanks for receiving the oil are shown in the background.

(Right) Aerial view shows primary clarifier in center with 10 secondary clarifiers on each side. The waste water enters through the culvert in the center and the effluent with 95% of oil removed flows out the canal at left.

300 Barrels Per Day Recovered

With increased demands for better methods of handling refinery waste water, systems using Hardinge Clarifiers as the primary separator have been gaining in popularity because of the high recovery of oil from the waste water. In this Ohio installation, the effluent from the Hardinge system contained 80 to 85% less oil than the previous system. Our engineers will provide you with the facts that you require.

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Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, June 19, 26 and July 3 and 10, 1951)

REFINING

U.S.P. 2,557,081. Process for Breaking Petroleum Emulsions. M. de Groote and B. Keiser to Petrolite Corporation, Ltd.

Details are claimed of a process for breaking petroleum emulsions of the water-in-oil type with the use of a hydrophile synthetic demulsifier of the type described in U.S.P. 2,499,390. This demulsifier is an oxyalkylation product of certain alpha-beta alkylene oxides and certain phenol-aldehyde resins which is fusible and soluble in organic solvents.

U.S.P. 2,557,257. Extracting Fractionation Process. R. E. Melrose to Shell Development Company.

Straight-chain hydrocarbons are separated from their liquid mixture with non-straight-chain hydrocarbons by contacting the mixture with an adqeous phase containing dissolved urea and a water-soluble nitrite, iodate, or chromate. Crystalline molecular complexes between urea and straight-chain hydrocarbons are formed thereby. The aqueous phase is subsequently separated from the remaining liquid hydrocarbons. The amount of the inorganic salt shall be at least sufficient to suppress emulsification.

U.S.P. 2,557,406. Solvent Extraction and Dewaxing of Mineral Oils. P. G. Blazer, A. M. Leas, and W. H. Humphreys to Ashland Oil and Refining Company.

Wax-bearing petroleum is mixed with a normally gaseous liquefied hydrocarbon diluent and 2-10 percent by volume of furfural. The mixture is chilled to a temperature below that of the solidification of wax bodies contained therein and that of the freezing point of the furfural. The mixture is then stratified into three layers, the upper one being essentially dewaxed oil in solution, the bottom layer consisting predominantly of furfural, and the middle layer consisting of a suspension of crystallized wax and crystallized furfural in liquefied diluent.

U.S.P. 2,557,684. Inhibiting Polymerization of Diolefins. J. M. Powers to Standard Oil Development Company.

For inhibiting the polymerization of diolefins with 4-8 C atoms under polymerization conditions, an amount of 0.001-1.0 percent by weight of a phenolic inhibiting compound with not more than 10 C atoms in an alkyl side chain, and an amount of 5-50 percent based on this inhibitor of an aliphatic carboxylic acid with 1-10 C atoms are maintained in the diolefin.

U.S.P. 2,557,923. Recovery of Olefin Hydrocarbons. G. C. Ray and E. O. Box, Jr., to Phillips Petroleum Company.

Olefins are separated from admixture with saturated hydrocarbons by contacting the mixture with a cuprous salt dissolved in methoxyethylamine.

U.S.P. 2,558,510-3. Processes for Breaking Petroleum Emulsions. M. De Groote, A. F. Wirtel, and O. H. Pettingill to Petrolite Corporation, Ltd.

A demulsifier for petroleum emulsions of the water-in-oil type includes at least one cogeneric mixture of a homologous series of glycol ethers of p-methylcyclohexanol, derived exclusively from the latter, ethylene oxide, and propylene oxide in specified proportions. According to U.S.P. 2,558,512-3, the p-methylcyclohexanol is replaced by p-cyclohexylcyclohexanol.

U.S.P. 2,558,587. Foam Prevention in Extractive Distillation of Hydrocarbons. D. S. Sherwin to Phillips Petroleum Company.

Details are claimed of a process for extractively distilling a mixture of hydrocarbons with furfural as a selective solvent.

U.S.P. 2,558,809. Fractionation of Reduced Crude Oil. B. C. Benedict to Phillips Petroleum Company.

Details are claimed for the fractionation and recovery of lubricating oil constituents from asphalt-containing lubricating oil stocks with propane.

U.S.P. 2,558,882. Hydrocarbon Compositions. L. S. Schmerling to Universal Oil Products Company.

A petrolatum-like cycloalkylpolyethylene contains a minor amount of a solid ethylene polymer with a molecular weight of 10,000-30,000 dissolved therein. The additive increases the m.p. of the cycloalkylpolyethylene.

U.S.P. 2,559,157. Separation of Isoparaffins. A. E. Hirschler to Sun Oil Company.

An isoparaffin is separated from a saturated liquid hydrocarbon mixture containing a major amount of this isoparaffin and a small amount of another isoparaffin as impurity. The mixture is filtered in liquid phase through activated carbon which selectively adsorbs said other isoparaffin, leaving the desired isoparaffin in relatively pure state.

U.S.P. 2,559,574. Composition and Method for Removing Oil Sludge. M. Weissberg to I. J. Rifkin and A. Turman.

The surface of a petroleum sludge is contacted with a solution of a minor proportion of an oil-soluble and hydrophilic surface-active agent in coal tar neutral oil of specific gravity at least one or in an aromatic neutral hydrocarbon oil of specific gravity at least one and boiling between 258-353° C. The surface active agent can be petroleum sulfonate, the condensate of triethylene glycol with oleic acid, or triethanolamine oleate. The sludge is dispersed by this treatment.

U.S.P. 2,560,193. Dehazing Hydrocarbon Oils. B. H. Shoemaker to Standard Oil Company of Indiana.

A substantially wax-free petroleum oil of low pour point which develops haze on being cooled to low temperature is intimately contacted with urea. The resulting reaction product of urea with the haze-forming substances is separated to obtain a haze-free oil.

U.S.P. 2,560,330. Method of Refining Kerosene with Bauxite and Sulfur Dioxide. R. C. Brandon to Standard Oil Development Company.

A hydrocarbon fraction boiling in the kerosene range is treated in the vapor phase at a temperature of 600-850° F. and a pressure of 0-50 psi. with bauxite. The fraction is then condensed and contacted in the liquid phase with liquid SO_2. A kerosene fraction of relatively low sulfur content is recovered.

U.S.P. 2,560,333. Process for Breaking Petroleum Emulsions. M. de Groote and B. Keiser to Petrolite Corporation, Ltd.

For breaking water-in-oil petroleum emulsions a synthetic demulsifier is used including oxyalkylation products of a certain type, an alpha-beta alkylene oxide and of a fusible organic solvent-soluble, water-insoluble phenolic resin of specific character.

U.S.P. 2,560,362. Acid Extraction of Mixed Olefin Hydrocarbons. C. E. Morrell and R. F. Robey to Standard Oil Development Company.

Acid extracts containing both dis-

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Patents

solved isomeric tertiary and normal mono-olefins are diluted to an acid concentration of 50-70 percent (by weight on a hydrocarbon free basis). The diluted extract is stripped with a suitable agent, such as steam, without further dilution to recover tertiary olefins from the extract. Normal olefins are subsequently recovered from the stripped tertiary olefin-free acid extract.

U.S.P. 2,560,373. Recovery and Purification of Durene. A. J. Schmidl to Standard Oil Development Company.

A hydrocarbon fraction containing at least 18 percent durene and boiling at 380-390° F. is chilled to 0-32° F. The durene containing crystals formed are separated from the chilled fraction and warmed to 85° F. to liquefy a portion of the crystals. The liquid formed is removed. Pure durene is recovered from the remaining crystals.

U.S.P. 2,560,489. Stabilized Leaded Gasoline. H. G. Smith and T. L. Cantrell to Gulf Oil Corporation.

A leaded gasoline contains stabilizing amounts of at least one phenol substituted by three alkyl groups of certain types, and at least one azomethine compound containing two aromatic groups, such as 2,4,6-tritertiarybutyl phenol and benzalxylidine.

CRACKING AND REFORMING

U.S.P. 2,557,748. Process for Hydrocarbon Conversion. G. E. Liedholm to Shell Development Company.

Hydrocarbon oils are converted to lower boiling hydrocarbon oils by a process claimed in detail, wherein the hydrocarbon charge is contacted under elevated pressure with the hot cracking effluent obtained from an intermediate fraction of material resulting from one of the numerous steps of the process. These steps comprise flashing, catalytic cracking, hydrogenation, decoking, etc., operations.

U.S.P. 2,559,285. Catalytic Cracking and Destructive Hydrogenation of Heavy Asphaltic Oils. W. C. Douce to Phillips Petroleum Company.

A dirty topped crude oil boiling above 800° F. is deasphalted by liquid propane. The resulting heavy oil is catalytically cracked in mixture with a virgin gas oil boiling at 550-800° F. The resulting effluent is separated into gas, gasoline, light gas oil, and heavy refractory gas oil. This refractory gas oil along with dirty asphaltic materials boiling above 1000° F. and separated from the crude by the propane treatment is subjected to destructive hydrogenation over a catalyst immune to sulfur poisoning. Further details are claimed for this process for producing gas, gasoline and gas oil.

U.S.P. 2,559,957. Pebble Heater. H. J. Hepp and M. O. Kilpatrick to Phillips Petroleum Company.

In the cracking of hydrocarbon vapors passing upwards in intimate contact with a gravitating bed of hot pebbles, special arrangements are made for introducing the pebbles to the contacting zone.

U.S.P. 2,560,511. Catalytic Cracking of Heavy Hydrocarbons in Two Stages. G. I. Jenkins to Anglo-Iranian Oil Company, Ltd.

A hydrocarbon feed stock boiling above the gas oil range is cracked in two stages. In the first stage conditions are employed such that relatively low feed stock destruction occurs and a high yield of gas oil for use as Diesel fuel is obtained. In the second stage the residue from the first stage is cracked under conditions such that relatively high feed stock destruction occurs and a high yield of good quality motor gasoline and a residue are obtained which constitutes a source of fuel oil with a low pour-point.

ALKYLATION

U.S.P. 2,557,113. Catalytic Reaction of Isoparaffin Hydrocarbons. R. M. Kennedy and A. Schneider to Sun Oil Company.

A tertiary C-containing isoparaffin is reacted in the presence of a catalyst comprising a mixture of BF_3 and an alkyl fluoride with at least 2 C atoms at a temperature of —120° to 150° C. Other tertiary C-containing isoparaffins are obtained by instantaneous reaction in homogeneous phase.

U.S.P. 2,557,114. Preparation of 2,3-Dimethylbutane. R. M. Kennedy and A. Schneider to Sun Oil Company.

2,3-dimethylbutane is prepared from

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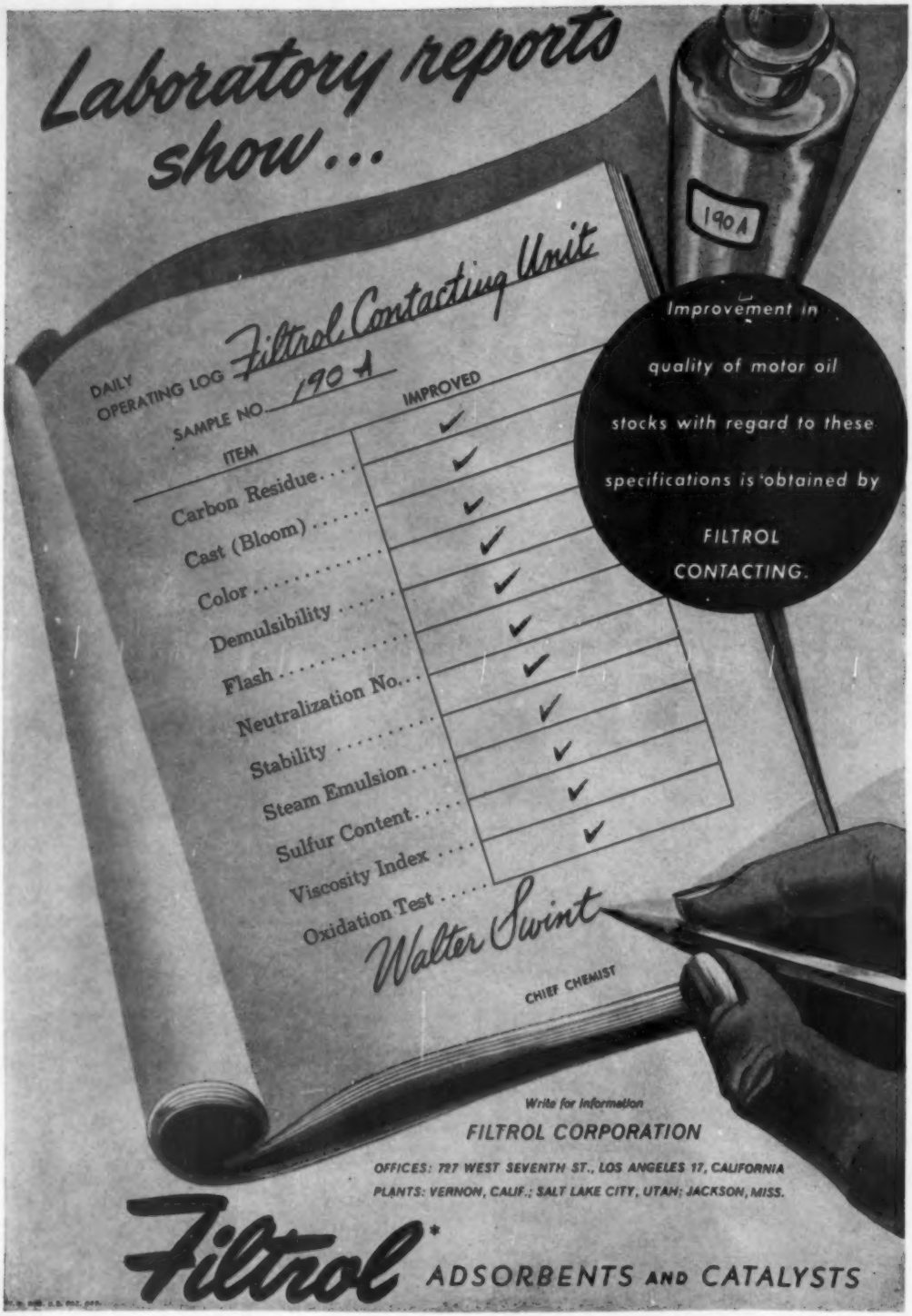
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ADSORBENTS AND CATALYSTS

isobutane and ethylene by a process closely related to that of U.S.P. 2,557,113 and in the presence of the same type of catalyst at a temperature of —90° to 150° C.

U.S.P. 2,557,115-6. Preparation of 2,2,4-Trimethylpentane. R. M. Kennedy and A. Schneider to Sun Oil Company.

The method according to U.S.P. 2,557,113 is here used for the preparation of 2,2,4-trimethylpentane either from isobutane and isobutylene, or from isobutane only.

U.S.P. 2,557,117. Self-Alkylation of Isopentane. R. M. Kennedy and A. Schneider to Sun Oil Company.

Isopentane dimer is prepared by self-alkylation of isopentane according to the method described in U.S.P. 2,557,113.

U.S.P. 2,557,118. Alkylation of Isobutane with Propylene. R. M. Kennedy and A. Schneider to Sun Oil Company.

Gasoline hydrocarbons are prepared by reacting isobutane with propylene according to the method of U.S.P. 2,557,113.

U.S.P. 2,559,818. Process for Production of Alkyl Benzenes. R. S. Hanmer to Phillips Petroleum Company.

Low boiling aromatic hydrocarbons are alkylated with a high molecular weight olefin in the presence of a liquid type catalyst. Details are claimed.

POLYMERIZATION AND CONVERSION

U.S.P. 2,557,094. Isobutylene-p-Chloro-Styrene - Styrene - Tripolymer. J. D. Garber to Standard Oil Development Company.

Fifty percent by weight of isobutylene is copolymerized with 25 percent of p-chloro-styrene and 25 percent of styrene in methyl chloride solution at a temperature of —100° C. in the presence of a methyl chloride solution of $AlCl_3$. A high molecular weight solid tripolymer resin with an intrinsic viscosity of 0.70 is produced.

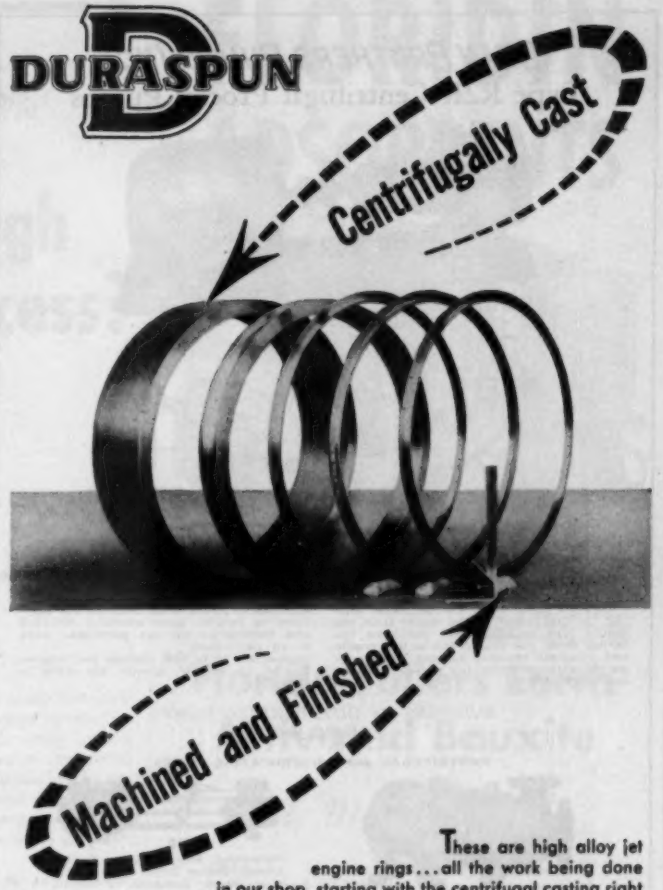
U.S.P. 2,557,363. Amine Activated Polymerization Process. G. E. Serniuk to Standard Oil Development Company.

An aqueous emulsion of a major proportion of a conjugted butadiene and a minor proportion of acrylonitrile and an alkali metal soap emulsifier is polymerized in the presence of potassium persulfate, an aliphatic mercaptan containing at least 6 C atoms and 0.05-0.5 percent of piperidine. Rubber-like materials are obtained.

U.S.P. 2,557,903. Diolefin-Aconitate Copolymers and Method of Making Same. R. F. Boyer and L. C. Rubens to The Dow Chemical Company.

About equimolecular amounts of an aliphatic conjugated diolefin and a saturated monohydric alcohol triester of aconitic acid are copolymerized, preferably at a temperature below 80° C. Substantially colorless, transparent solid products are obtained.

U.S.P. 2,558,194. Apparatus for the Fluid Catalytic Conversion of Different Hydrocarbon Feeds. G. Crescan to Uni-



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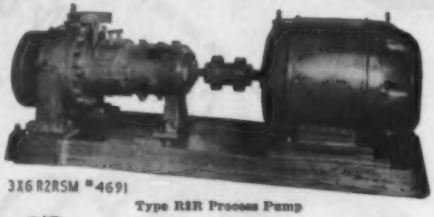
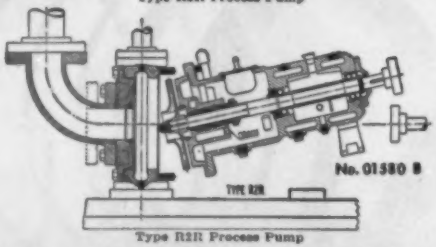


3X6 R2RSM #4691

Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

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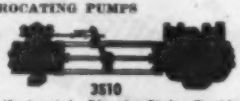

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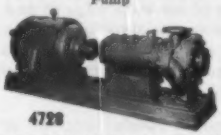

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versal Oil Products Company.

The construction is claimed of an apparatus for effecting contact between fluid reactants and finely divided solid catalyst particles. The apparatus is useful for effecting the conversion of more than one type of charging stock.

U.S.P. 2,558,375. Catalytic Conversion of Hydrocarbons. L. E. Olson to Sinclair Refining Company.

A hydrocarbon oil stock is passed at conversion conditions in intimate contact with an Al-halide catalyst. Spent catalyst is removed from the reaction zone. A perfluorinated oil stock is converted in a separate zone. The reaction products of this zone including HF are contacted in a third zone with the spent Al-halide catalyst to recover the HF as a reaction product between the HF and the Al-halide catalyst. High anti-knock gasoline is produced.

U.S.P. 2,588,769. Process for Control of Hydrocarbon Reactions in Moving Solids Contacting Systems. D. D. McKinney to Houdry Process Corporation.

In the conversion of heavy petroleum stocks charged to the reaction zone in at least partially liquid phase, a first portion of clean contact material is introduced at conversion conditions to the reaction zone to form the upper surface of a gravitationally descending bed of contact material. Petroleum stock is supplied to the upper of this bed as a spray from a distributing source above this bed. A second portion of the contact material is introduced at corresponding conditions into the descending bed directly at a level below the upper surface of the bed and in a transversely limited area directly beneath the liquid distributing source. Local concentrations of coke and unprocessed oil from liquid dripping in undispersed state upon the contact bed are minimized.

U.S.P. 2,558,838. Treatment of Catalytic Gas Oils. L. B. Goodson to Phillips Petroleum Company.

A gas-oil produced in a catalytic cracking operation is extracted with an alkylatable aromatic extraction solvent to produce a raffinate containing olefins and an extract containing dissolved aromatic hydrocarbons from the gas-oil. The raffinate enriched with additional alkylatable aromatics is catalytically alkylated to form one of the process products. The extract is further treated to separate aromatic gas-oil constituents as another product.

U.S.P. 2,558,861. Apparatus for Production of Acetylene and Other Hydrocarbons. P. T. Liggett to Universal Oil Products Company.

The construction is claimed of an apparatus for the pyrolytic conversion of a hydrocarbon gas stream to form acetylene and the like.

U.S.P. 2,559,062. Friedel-Crafts Metal Halide-Ether Complexes as Polymerization Catalysts. R. W. Dornte to Standard Oil Development Company.

In the polymerization of isobutylene, styrene, or isoprene at a temperature between —10° and —103° C. a catalyst is added to the cold hydrocarbon material which comprises $AlCl_3$, $TiCl_4$, or

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By permitting water, aqueous solutions or any volatile liquid to evaporate under high vacuum and without heat from an outside source, enough BTU's can be removed to chill the liquid down to 32° F., or even lower in the case of solutions. This is the principle of the Croll-Reynolds "Chill-Vactor." Hundreds of these have been installed throughout the United States and in several foreign countries.

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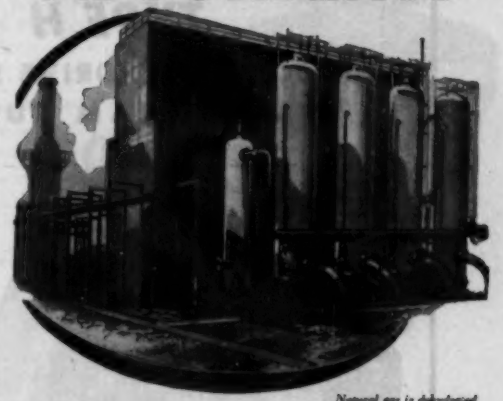

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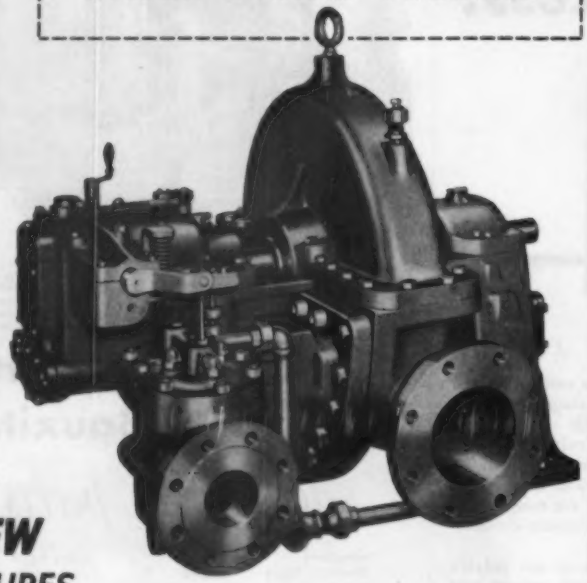

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Patents

BF_3, and anisol, 1,2-diphenoxyethane, diphenylether, or beta, beta'-dichloroethylether. This catalyst complex shall consist of no more than 40 moles of the ether per mole of the metal halide. The use of the complex allows a substantial control of the polymerization reaction.

U.S.P. 2,559,576. Process for Polymerization with Tetraborohypophosphoric Acid Catalyst. W. W. Johnstone to Universal Oil Products Company.

Olefins and diolefins are polymerized in the presence of $B_2O_7(H_2P_2O_4)_2$.

U.S.P. 2,559,646. Conversion Apparatus and Associated Arrangement for Controlling Distribution of Gases Passing Therethrough. R. C. Lassiat and J. E. Evans to Houdry Process Corporation.

The construction is claimed of a conversion apparatus provided with an arrangement for controlling distribution of gases during their passage through a reaction chamber containing a fixed bed of catalytic material.

U.S.P. 2,559,749. Fluorinated Aliphatic Phosphates as Emulsifying Agents for Aqueous Polymerizations. A. F. Benning to E. I. du Pont de Nemours & Company.

Monomeric ethylenically unsaturated compounds are polymerized in an aqueous medium in the presence of a water-soluble polymerization initiator and a dispersing agent of the formula $(B[CF_2]_nCH_2)_2$ A, wherein B is hydrogen or fluorine, n is an integer of 2-4, and A is a phosphate group. A colloidal polymer dispersion is obtained.

U.S.P. 2,559,876. Device for Controlling the Level of Subdivided Solid Particles within a Contacting Chamber. J. Hoekstra to Universal Oil Products Company.

The flow of subdivided solid particles to the top of a solids bed maintained within a contacting chamber is controlled by a self-regulating feeding device, the construction of which is claimed.

U.S.P. 2,559,947. 1,2-Diolefins as Modifiers in the Alkali-Metal-Catalyzed Polymerization of Conjugated Dienes. W. W. Crouch to Phillips Petroleum Company.

A mixture of a major amount of a 1,3-diolefin and a minor amount of a vinyl aromatic compound is polymerized in the presence of a finely divided alkali metal catalyst with the addition of 25-200 parts of a paraffin, cycloparaffin, or aromatic diluent and 0.01-0.5 part of 1,2-butadiene. A rubber-like polymer is produced.

U.S.P. 2,560,027. Continuous Polymerization of Butadiene and Styrene. J. N. Street and R. F. Dunbrook to The Firestone Tire and Rubber Company.

Details are claimed of a continuous method for the manufacture of synthetic rubber from 75 parts 1,3-butadiene, 25 parts styrene, 180 parts water, an emulsifying agent and a polymerization catalyst.

U.S.P. 2,560,340. Polymerization Process. A. D. Green and E. T. Marshall

to Standard Oil Development Company.

In a polymerization process, a feed comprising isobutylene, isoprene and CH_3Cl as a diluent is chilled below 0° C. to remove any moisture present by formation of ice. This ice is removed from the chiller by directly contacting it with a gas mixture of 85 percent CH_3Cl and 15 percent isobutylene under pressure such that the gas condenses above 0° C., so that the ice melts and the resulting water can be continuously removed.

U.S.P. 2,560,343. Catalytic Conversion Process. C. E. Hemminger to Standard Oil Development Company.

In a continuous catalytic conversion process using a downwardly moving bed of catalyst which is regenerated and recycled, the space velocity of the hydrocarbons through the catalyst bed is reduced by increasing the volume of the bed as the activity of catalyst entering the bed diminishes without interrupting the flow of hydrocarbons therethrough.

U.S.P. 2,560,356. Fluidized Powder Flow and Control. G. E. Liedholm to Shell Development Company.

Details are claimed of a process for contacting two different gaseous fluids in separate contact zones with a fluidized powder which is continuously recycled through these zones.

U.S.P. 2,560,492. Copolymers of Substituted Styrenes and Polyolefins. W. J. Sparks and D. W. Young to Standard Oil Development Company.

5-80 percent of a substituted styrene containing 1-2 alkyl substituents of 1-2 C atoms, each, and 95-20 percent of a polyolefin of 4-10 C atoms are copolymerized at a temperature of 0° to —103° C. in the presence of a Friedel-Crafts catalyst.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,557,701. Catalytic Reaction of Olefins with Carbon Monoxide and Hydrogen. W. M. Smith to Standard Oil Development Company.

Details are claimed of a continuous process for the exothermic synthesis of aldehydes from olefins, CO and H_2 in the presence of a cobalt carbonylation catalyst in an adiabatic reaction zone, the resulting aldehydes containing one more C atom than the olefins employed. The temperature level of the reaction zone is controlled, and high concentration of the catalyst is maintained throughout the carbonylation reaction zone.

U.S.P. 2,557,842. Hydrocarbon Synthesis with Fluidized Catalyst. R. F. Ruthruff, Chicago.

In a Fischer-Tropsch synthesis, water gas containing CO and H_2 in the approximate volume ratio of 1:1 is divided into two parts in the approximate proportions 2:1 by volume. The larger part thereof is introduced at an intermediate point into a fluidized bed of synthesis catalyst. The smaller part is mixed with about 0.5 volume of steam, and the re-

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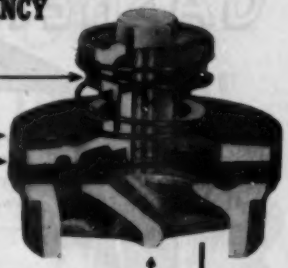

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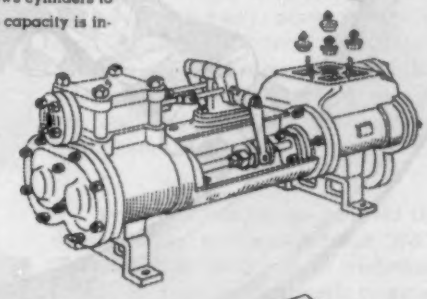

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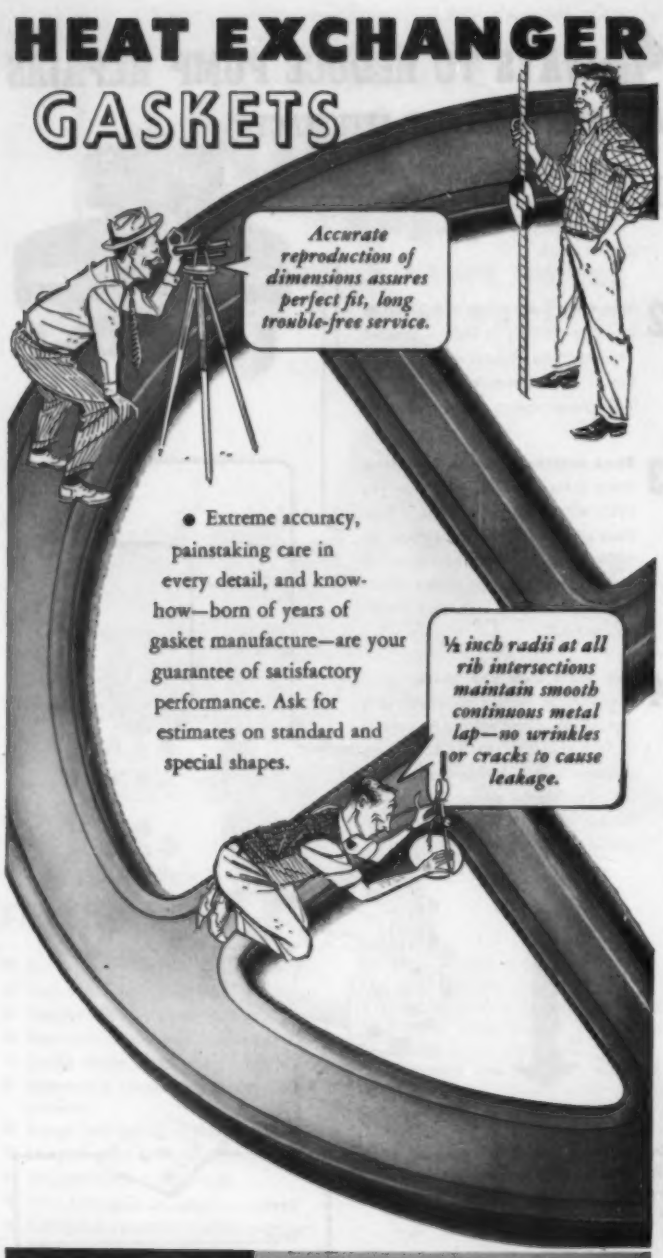
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UGS

Patents

sulting mixture is reacted under conditions effective for the conversion into H_2 and CO_2. The CO_2 is removed from this product, and the residual H_2 is introduced into the catalyst bed at a low point to pass upward to the entrance point of the water gas and react therewith.

U.S.P. 2,558,556. Production of Hydrocarbons and Oxygenated Compounds. H. V. Hess and G. B. Arnold to The Texas Company.

In a Fischer-Tropsch synthesis at a temperature of 250-700° F. and a pressure of atmospheric to 1000 psi., the resulting mixture of hydrocarbons, water and oxygen-containing compounds, mainly aliphatic alcohols, is separated at a temperature of 200-350° F. and elevated pressure into a gas phase, a hydrocarbon phase containing substantially all of the C_3 and higher alcohols and a substantial part of ethyl alcohol, and a water phase containing the other portion of alcohols produced. The hydrocarbon phase is fractionated into a gasoline fraction and a gas oil fraction. C_3 and C_4 alcohols separated from the gasoline fraction are used to extract oxygenates from the gas oil fraction.

U.S.P. 2,558,557. Extraction of Alcohols from the F-T Synthesis Product. H. V. Hess and G. B. Arnold to The Texas Company.

The process according to this patent is closely related to that of U.S.P. 2,558,556. The alcohols here produced have 1-20 C atoms. The hydrocarbon phase separated at atmospheric conditions contains the major portion of the alcohols with more than 5 C atoms and a substantial portion of the C_4 and C_5 alcohols, while the aqueous phase contains the remainder of the alcohols. A distillate formed from the aqueous phase consists of an aqueous azeotropic mixture of alcohols, the C_1-C_3 alcohol fraction of which is employed for extracting the hydrocarbon phase. Further details are claimed.

U.S.P. 2,558,746. Production of Carbon Monoxide and Other Gases from Carbonaceous Materials. L. P. Gaucher to The Texas Company.

Details are claimed for the production of a CO/H_2 mixture from a solid carbonaceous fuel by reaction with oxygen and steam.

U.S.P. 2,558,760. Hydrocarbon Synthesis. P. C. Keith to Hydrocarbon Research, Inc.

Details are claimed of a Fischer-Tropsch synthesis from a CO/H_2 mixture obtained by partial combustion of a hydrocarbonaceous material at a temperature of at least 2100° F. with oxygen.

U.S.P. 2,560,171. Synthesis of Organic Compounds. L. R. Hill to The M. W. Kellogg Company.

A CO/H_2 mixture with a mol ratio of H_2 to CO between 0.7:1 to 10:1 is passed upwardly at a specified velocity through a reaction zone in the presence of a fluidized catalyst at a temperature of 350-750° F. and a pressure of 50-500 psi. A portion of the gaseous effluent is recycled.

Patents

U.S.P. 2,560,325. Hydrocarbon Synthesis. H. T. Baker to Standard Oil Development Company.

A mixture of 1-2 mols hydrogen per mol of CO is contacted with a fluidized bed of powdered alkali metal salt-promoted iron catalyst under synthesis conditions. The flow of synthesis gas to the reaction zone is interrupted about every 24 hours. The fluidized bed is treated with a gas consisting predominantly of hydrogen under the same conditions as before for a period of 15 minutes to 2 hours and until the effluent gas from the reaction zone is at least 90 percent H_2. Thereafter, synthesis gas is again passed under synthesis conditions into the reaction zone. During the transition period over 20 percent of the catalyst is converted into Fe_5C.

U.S.P. 2,560,329. Catalytic Dehydrogenation of Petroleum Naphthenes. R. C. Brandon to Standard Oil Development Company.

A petroleum mono-alkyl naphthene is passed in vapor form over a catalyst containing 0.1-10 percent by weight of a platinum group noble metal mixed with a hydrous oxide carrier having ultra-microscopic pores at a temperature of 650-800° F.

U.S.P. 2,560,344. Two Stage Hydrocarbon Synthesis Operation. C. E. Hemminger to Standard Oil Development Company.

A synthesis gas containing H_2 and CO in a molecular proportion of 1 to 2:1 is contacted together with 2-8 percent (by volume of the synthesis gas) of extraneous water vapor with a fluidized iron-type catalyst, promoted with 1-8 percent by weight of an alkali metal compound, at a temperature of 350-600° F., a pressure of 550-700 psi., a space velocity of 2-30 cubic feet of gaseous mixture per hour per pound of catalyst, and a ratio of recycle to fresh feed gas of 1-2 volumes recycle per volume of fresh feed. The unconverted gases of the vaporous reaction effluent are treated after separation from the reaction products with a portion of previously used catalyst at a temperature of 550-750° F., a pressure of 200-500 psi., and a space velocity of 10-75 cubic feet of gas per hour per pound of catalyst. Further amounts of hydrocarbons are thus formed.

U.S.P. 2,560,345. Pretreatment of Catalyst for Hydrocarbon Synthesis. C. E. Hemminger to Standard Oil Development Company.

In a Fischer-Tropsch synthesis employing a fluidized iron catalyst, an oxygen-containing iron catalyst is first reduced with hydrogen to an oxygen content of 0-10 percent by weight of the iron. The reduced catalyst is then treated with fresh synthesis gas at a temperature of 550-750° F. and a pressure substantially lower than the increased synthesis pressure for a time sufficient to carbide the catalyst and convert 20-50 percent of its iron content into a mixture of iron carbides with predominating Fe_5C content. The catalyst thus pretreated remains at a high activity level while its tendency to undergo fragmentation is repressed.

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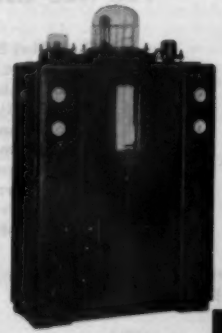

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Patents

U.S.P. 2,560,360. Synthesis of Oxygenated Organic Compounds. J. K. Mertzweiller and J. J. Owen to Standard Oil Development Company.

Olefins produced in a Fischer-Tropsch synthesis are treated with an alkaline agent for removing acidic materials from the olefins. Thereafter, the olefins are contacted with H_2 and CO in the presence of an oxygenation catalyst at suitable conditions to produce oxygenated organic materials, such as aldehydes and ketones.

DESULFURIZATION

U.S.P. 2,558,137. Process for Sulfur Removal. H. J. Hepp to Phillips Petroleum Company.

A normally gaseous olefin-containing hydrocarbon mixture is desulfurized by treatment in the presence of a silica-alumina type catalyst at a temperature of 150-550° F., and a pressure of 500-2000 psi. under conditions claimed in detail.

U.S.P. 2,558,863. Process for Refining Petrol. L. B. Lundquist to Svenska-Skifferolje Aktiebolaget, Sweden.

Petroleum containing CS_2 and mercaptans is first treated with aqueous alkaline lye and then with H_2SO_4. The product is then distilled after neutralization with alkaline lye. A light fraction of the distillate contains all CS_2 and some light mercaptans, while a heavier fraction is free of CS_2 but contains at least the heavier mercaptans. The light fraction is treated with alcoholic lye to convert the light mercaptans into mercaptides, while the heavier fraction is treated with sodium plumbite and sulfur for converting its mercaptans into disulfides.

U.S.P. 2,559,323. Process for the Desulfurization of Hydrocarbons. P. X. Spillane to Keith Williams, Sydney.

Hydrocarbons are contacted in the vapor phase at temperatures of 80-400° C. with a desulfurizing agent comprising agent comprising essentially at least one alkali carbonate and metallic iron. This agent is prepared in a special manner claimed in detail.

U.S.P. 2,559,324. Treatment of Sulfur-Containing Materials. P. X. Spillane to Keith Williams, Sydney.

The subject of this patent is closely related to that of U.S.P. 2,559,323. The desulfurizing catalyst characterized by the special manner of production is claimed as well as the conversion of gaseous sulfides into elemental sulfur with the aid of this catalyst and in the presence of oxygen or CO or CO_2.

U.S.P. 2,559,457. Hydrodesulfurization of Petroleum Hydrocarbons. C. W. Montgomery, W. I. Gilbert, and S. M. Hazen to Gulf Research & Development Company.

Vapors of a petroleum hydrocarbon and hydrogen-containing gas are contacted with Ni or Ni oxide on a carrier. Sulfur contained in said vapors is absorbed with formation of Ni sulfide. The contact material is regenerated and reused. Powdering of this material by repeated regeneration is reduced by an admixture of 5-11 percent of copper to the Ni-contact.

U.S.P. 2,560,178. Regenerating Mercaptan Solvent. J. H. Krause and T. B. Tom to Standard Oil Company of Indiana.

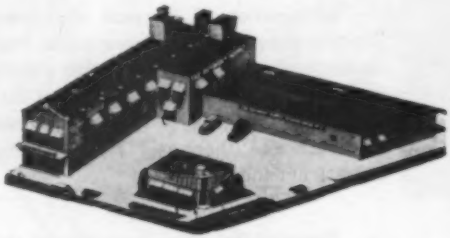
A petroleum distillate within the kerosene to heater oil boiling range is extracted at a temperature of 80-100° F. with an aqueous 50-65 percent KOH solution and a certain amount of methanol, to remove mercaptans. The extracting liquid is regenerated in a manner claimed in detail.

U.S.P. 2,560,374. Treatment of Sour Petroleum Distillates. A. J. Schmidl to Standard Oil Development Company.

A sour petroleum distillate containing mercaptans and having a final b.p. no greater than 750°F. is admixed with not more than one percent by volume of an alkanol amine, such as triethanol amine. The mixture is agitated with not more than five percent by volume of a solution of an alkali metal hydroxide while adding a sufficient amount of a mild oxidizing agent to convert the mercaptans to disulfides. A sweetened distillate results.

U.S.P. 2,560,433. Desulfurization of Hydrocarbon Oils. W. I. Gilbert and W. A. Horne to Gulf Research & Development Company.

Vapors of a S-containing hydrocarbon oil are contacted with an agent consisting of metals of the iron group or their oxides composited with a silica-alumina refractory catalytic material capable of promoting the conversion of higher boiling into lower boiling hydrocarbons and



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DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

September ★ One of a Series of Interest to the Petroleum Industry ★ 1951

New Houston Office for Gulf Coast District

The Gulf Coast District Office of the Du Pont Petroleum Chemicals Division will soon move into its new Houston headquarters. The new offices are located in the recently completed National Bank of Commerce Building. They are considerably larger than those formerly occupied by the Division's Houston staff and pleasant surroundings have been created by one of Houston's leading decorators.

Superintendent of TEL Manufacturing Area

H. CLIFFORD BAILEY is superintendent of the Tetraethyl Lead Area of the Du Pont Chambers Works at Deepwater, N. J. He joined the Company in 1924 after graduating from M.I.T. and started his Du Pont career as a chemist in the Jackson Laboratory.

H. CLIFFORD BAILEY

In 1925 he was transferred to the Chambers Works. Here he held three jobs successively as a supervisor of the Phenylglycine operation, the Indigo Area and in the Tetraethyl Lead Area. In 1937 he was transferred to the Baton Rouge, La. plant as assistant manager.

After a period in military service he returned to Du Pont and was made technical assistant, Petroleum Chemicals Division, at the Wilmington office. In 1950 he was transferred to the Chambers Works to his present job of superintendent in charge of TEL manufacture.

New Du Pont Color Movie Dramatically Depicts Safe Gasoline Transport by Tank Truck

Film Available to Petroleum Industry for Showings to Municipal Authorities, Safety Groups, Civic Organizations

WHAT do Mr. and Mrs. America think of your gasoline trucks? Judging from reports in publications, and various restrictive regulations, they have some false notions about the safety of these vehicles. Since tank trucks are indispensable, something has to be done to change their minds. But what?

"IS THAT GASOLINE TRUCK SAFE?" asks a finicky lady motorist of our tank truck driver. In the new Du Pont movie, his clear explanation of the facts convinces her that the truck *is* safe.

To help the petroleum industry overcome this prejudice, Du Pont has produced a full-color sound movie on tank truck safety. This film is available to oil companies. It is a Hollywood-produced picture entitled "Pipeline on Wheels." The film is specially designed to give the public the facts about the safety features found in tank trucks built today.

Realistic acting and careful script writing point up the story. Forcefully and memorably the new film presents a winning case for the tank truck. Its message is in the form of an entertaining human-interest story. The chief characters, played by Hollywood actors, appear as typical, motoring-conscious Americans.

Throughout the picture, four main points are stressed: (1) The importance of the gasoline tank truck in our modern motorized civilization. (2) The fact that tank trucks are engineered and constructed for great strength and safety. (3) Evidence that tank trucks protect and retain their cargo even when rolled over or exposed to fire. (4) That size is no evil in tank trucks because large loads mean fewer trucks on the highway and, consequently, fewer exposures to traffic hazards.

Besides filling a definite need in public education, the film is ideal for training use. It can be employed effectively to develop job pride among tank truck drivers and maintenance men. Step by step, it shows how the modern tank truck is built to strict specifications for maximum safety. In two spectacular

SPECIAL

In this issue . . .

see back page for progress story on Du Pont's new TEL manufacturing facilities.

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OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED

New Movie

demonstrations with a full-size tank trailer loaded with actual gasoline, the movie proves conclusively that a gasoline truck can be rolled over without spilling and that it will not explode—even when subjected to severe fire beneath it.

In preparing the script, Du Pont consulted representatives of the Board of Fire Underwriters, the National Safety Council, the National Fire Protection Association, the API and NPA, as well as many automotive engineers and oil company personnel—over 100 people in all. These men cooperated enthusiastically and many offered sound suggestions which were incorporated in the film. As a result, "Pipeline on Wheels" is as authoritative as it is possible to make it.

THE SAFE CONSTRUCTION of a gasoline tank truck is stressed in this driver training scene from "Pipeline on Wheels."

Prints of the film are available to oil companies for use as they see fit and may be borrowed or purchased through any Du Pont Petroleum Chemicals Division District Office. The showing time is 26 minutes.

"Pipeline on Wheels" provides a feature attraction around which can be planned meetings with civic organizations, public officials, fire or police departments and other interested groups. And it provides a valuable supplement to training programs for tank truck drivers and oil industry personnel in general.

THIS "TAKE-HOME" BOOKLET, describing the movie in detail, is available to oil companies for distribution in connection with showings of "Pipeline on Wheels."

New TEL Manufacturing Facilities Well Under Way at Du Pont

To help meet the growing demand for tetraethyl lead compounds, construction of Du Pont's new manufacturing plant is now well under way at Deepwater, N. J. These facilities, using a new, more efficient manufacturing process, are expected to be in production by January, 1952.

As a result, refiners can look forward to an additional supply of TEL to help them maintain their quality standards and to meet increased gasoline demands. Also, TEL will be more readily available whenever its need for military fuels is urgent.

Construction of the new facilities is being accomplished with a minimum of critical defense materials. The specially designed processing equipment, for example, requires a smaller amount of special steel alloys than the former type.

To keep construction moving at top speed, a crew of nearly 200 men is employed in building the new three-story plant. The building itself is on the Du Pont Chambers Works grounds near the present TEL manufacturing area. Du Pont also plans to maintain full production in the present facilities.

AS THE STEEL WORK of Du Pont's new TEL plant nears completion, the job foreman checks construction details.

LITERATURE AVAILABLE

The Petroleum Chemicals Division of Du Pont has published a wide variety of material of interest to the petroleum industry. This includes technical papers, bulletins, reports and memoranda as well as equipment operation bulletins, safety regulations, tank cleaning data, marketing aids and the like.

Any of this is available on request to your nearest Du Pont Petroleum Chemicals Division District Office. A partial listing of available material is shown below:

Possible Mechanisms By Which Combustion Chamber Deposits Accumulate and Influence Knock . . . . . Serial A-2087a

Tank Talk—a 52-page booklet which outlines safe procedure for cleaning gasoline storage tanks. Written for the man who does the cleaning . . . . . Serial A-1134

Antiknock Antagonists—by H. K. Livingston, Jackson Laboratory

Du Pont Services to the Petroleum Industry . . . . . Serial A-663

MOVIES AVAILABLE

Pipeline on Wheels—A 26-minute, full-color movie on tank truck safety. Suitable for both training and public relations purposes.

What Makes A Gasoline Good—An 18-minute cartoon movie in color. Presents the story of how high quality gasoline is made in easy-to-understand form. Ideal for dealer training meetings.

In addition to the above, Du Pont makes available a special library of films of particular interest to the petroleum industry.

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having a conversion index of about 15, in the presence of hydrogen at a temperature of 600-950°F. The treatment is terminated when a substantial amount of H_2S appears in the vapors. The contact agent is regenerated for sulfur removal.

HEAVY OILS AND WAXES

U.S.P. 2,557,940. Refining of Lubricating Oils. P. H. Carnell to Phillips Petroleum Company.

Lubricating oil is refined by treatment with anhydrous HF and an isoparaffin at elevated temperatures and pressure. The treated mixture is cooled and then thoroughly mixed with a phenolic compound. An acid phase containing the HF and the phenolic compound is separated from a hydrocarbon phase which is distilled to recover the improved lubricating oil.

U.S.P. 2,558,079. Mineral Lubricating Oil Containing Chlorinated Hydrocarbons. B. Gallsworthy to The Texas Company.

A mineral lubricating oil contains a minor amount of chlorinated mineral lubricating oil. The lubricant has extreme pressure characteristics.

U.S.P. 2,559,083. Decolorization of Polyolefinic Hydrocarbon Drying Oils. P. D. May, L. M. Adams, and R. J. Lee to Pan American Refining Corporation.

Darkcolored hydrocarbon drying oil of special characteristics and essentially consisting of polyolefins with ring structure is contacted with hydrogen in the presence of a solid hydrogenation catalyst under mild hydrogenation conditions for a period of time sufficient to hydrogenate at least a substantial portion of the chromophoric components of the oil but insufficient to decrease the iodine number of the oil by 20 percent.

U.S.P. 2,559,645. Method of Blending Polyethylene-Amorphous Petroleum Wax Compositions. R. G. Larsen and A. A. Schaerer to Shell Development Company.

An ethylene polymer having a molecular weight of 6000-140,000 is homogeneously blended with an equal amount of an amorphous petroleum wax having an m.p. of 40-88°C. and further treated.

U.S.P. 2,559,984. Process of Preparing Polymeric Lubricating Oils. C. W. Montgomery, W. I. Gilbert and R. E. Kline to Gulf Research & Development Company.

An olefin with at least three C atoms is continuously contacted in the liquid phase with a halide polymerization catalyst at a temperature of —20° to 40°C. until 10-20 percent polymer is formed. A lubricating oil is obtained.

U.S.P. 2,560,148. Wax Emulsion. K. G. Arabian to Shell Development Company.

A wax emulsion comprises a hydrocarbon wax, water, a water-soluble aliphatic hydroxy polycarboxylic acid, e.g. citric acid, and a salt thereof with a wax-soluble primary alkyl amine, e.g. hexadecyl amine, in certain proportions.

U.S.P. 2,560,202. Rust Inhibiting Composition. J. C. Zimmer, G. W. Duncan, and C. E. Paxton to Standard Oil Development Company.

A mineral base lubricating oil contains 0.5-3 percent by weight of a monooleic ester of pentaerythritol and 0.5-3 percent of a sodium or calcium petroleum sulfonate. The composition has rust-inhibiting characteristics.

U.S.P. 2,560,448. Recovery of Lubricating Oil from Solvent Extracts. W. C. Jones, Jr., to Standard Oil Development Company.

High viscosity index lubricating oil fractions are obtained from low viscosity index solvent extracts of lubricating oils by forming a mixture of these extracts which contain high viscosity index components and a light paraffin. The mixture is contacted with a bed of silica gel of 28-350 mesh particle size at a temperature of 60-200° F., with the gel being in excess of the extract. Low viscosity index constituents are selectively adsorbed. High viscosity index lubricating oils are recovered from the unadsorbed mixture.

U.S.P. 2,560,479. Production of Lubricating Oils. G. Riethof, C. W. Montgomery, and G. P. Brown, Jr., to Gulf Research & Development Company.

Lubricating oil is produced by subjecting a solvent extract of a lubricating oil distillate stock containing at least 15 percent (by weight of the solvent extract) of hydrocarbons boiling between 300-400° C. at 10 mm. Hg absolute pressure, to distillation under conditions claimed in detail, and then subjecting these separated hydrocarbons to a mild

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*17% of the 222 occupational injuries which occur every hour are due to falls. Source: National Safety Council's 1949 edition of Accident Facts.

Patents

sulfonation under specified conditions. Good quality petroleum sulfonates are obtained as a by-product.

PETROCHEMICALS

U.S.P. 2,557,281. Oxidation of Petroleum Cyclohexane. C. H. Hamblet and F. S. Chance to E. I. du Pont de Nemours & Company.

Details are claimed of a process for manufacturing partial oxidation products of cyclohexane, including cyclohexanol and cyclohexanone, from a petroleum cyclohexane crude containing at least 0.1 percent of benzene. The crude is reacted in the liquid phase with gaseous oxygen at a temperature of 75-200° C. under a pressure of 50-500 psi. in the presence of a catalytic amount of a hydrocarbon-soluble cobalt compound, such as cobalt naphthenate.

U.S.P. 2,557,282. Adipic Acid Process. C. H. Hamblet and A. McAlevy to E. I. du Pont de Nemours & Company.

Cyclohexane is oxidized with air at a temperature of 50-75° C. and under a pressure of 50-250 psi. under specific conditions followed by nitric acid oxidation at a temperature of 40-90° C. of the reaction product freed from unchanged cyclohexane. Adipic acid is produced.

U.S.P. 2,557,505. Production of Diarylalkanes. V. N. Ipatieff and H. Pines to Universal Oil Products Company.

An aromatic hydrocarbon with two hydrocarbon radical substituents in p-position to each other at least one of which radicals has only two H atoms combined with the C atom that is joined to the aromatic ring, is reacted at hydrogen transfer conditions with a tertiary alkylated phenol in the presence of an acid-acting catalyst. Unsymmetrical diarylalkane hydrocarbons are produced.

U.S.P. 2,557,643. Conversion of Hydrosulfides to Neutral Sulfur Compounds. L. C. Fetterly to Shell Development Company.

Hydrocarbon hydrosulfides are contacted with an oxygen-containing oxidizing agent in the presence of a non-alkaline aqueous solution having a pH not greater than six and of an indigo compound having an aromatic ring which is substituted with a polar water-solubilizing radical. Hydrocarbon disulfides are formed.

U.S.P. 2,557,664. Thiophene Preparation from Hydrocarbon and Sulfur Dioxide. K. L. Kreuz to The Texas Company.

SO_2 and a hydrocarbon having an aliphatic chain of at least four C atoms are reacted in vapor phase at a temperature of at least 700° F. in the presence of a solid particulate surface-active dehydrogenation catalyst at a space velocity of less than five. A thiophene is produced.

U.S.P. 2,557,665. Thiophene Preparation from Alkane and Sulfur Dioxide. K. L. Kreuz to The Texas Company.

The process of this patent is closely related to that of U.S.P. 2,557,664. An alkane with at least two C atoms is

Patents

reacted with SO_2 at a temperature of at least 800° F. and a space velocity of 0.2-6 weight of alkane per hour per weight of catalyst.

U.S.P. 2,557,666. Thiophene Preparation from Alkene and Sulfur Dioxide. K. L. Kreuz to The Texas Company.

The process according to this patent differs from that of U.S.P. 2,557,665 essentially in that alkenes with at least two C atoms are employed instead of the corresponding alkanes.

U.S.P. 2,557,678. Thiophene Preparation from Hydrocarbons, Alcohols, or Monohalo Hydrocarbons and Sulfur Dioxide. M. Neuhaus, R. E. Conary, and L. W. Devaney to The Texas Company.

The process of this patent is closely related to that of U.S.P. 2,557,665. The solid catalyst is maintained in a fluid state.

U.S.P. 2,557,924. Manufacture of Hydrazoic Acid. R. E. Schaad to Universal Oil Products Company.

An unsaturated hydrocarbon of the formula $RCH{=}CH_2$ wherein R is an alkyl radical is reacted with hydrazoic acid in the presence of an acid-acting catalyst, such as H_2SO_4. Alkyl acids with at least two C atoms are produced.

U.S.P. 2,558,221. Oxidation of Mercaptans. C. W. Mertz, H. W. Cutcher, and J. A. McBride to Phillips Petroleum Company.

A tertiary alkyl mercaptan with not more than six C atoms is reacted with oxygen in the presence of an activated natural bauxite of special composition. The corresponding di-tertiary alkyl sulfide is obtained.

U.S.P. 2,558,363. Photocatalytic Manufacture of Benzene Hexachloride. A. J. Kolka and H. D. Orloff to Ethyl Corporation.

The photocatalyzed chlorination of benzene to its hexachloride is effected in the presence of an organic carboxylic acid or its anhydride or of chlorocarboxylic acids or carboxylic acid chlorides. The output in gamma isomer is increased by the additive.

U.S.P. 2,558,507. Production of Thiophene Compounds from Mono-Olefins and Hydrogen Sulfide with Alumina Catalyst. W. G. Appleby and A. F. Sartor to Shell Development Company.

Normally gaseous mono-olefin is contacted in mixture with H_2S in a molar ratio of H_2S to olefin of 2:1 to 6:1 with adsorptive alumina for 10-30 seconds at a temperature of 400-750° C. to produce thiophene compounds.

U.S.P 2,558,508. Thiophene Production from Hydrogen Sulfide and Mono-Olefin. W. G. Appleby and A. F. Sartor to Shell Development Company.

The process of this patent is closely related to that of U.S.P. 2,558,507. Butylene is here reacted with H_2S under similar conditions.

U.S.P. 2,558,716. Thiophene Preparation from Hydrocarbons, Alcohols, or Mono-Halo Hydrocarbons and Sulfur Dioxide. L. W. Devaney, J. T. Clarke

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CONCERNED ABOUT LOSSES RESULTING FROM VOLUME SHRINKAGE AT LOW OIL DELIVERY TEMPERATURES?
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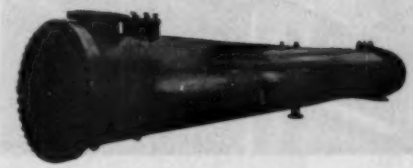

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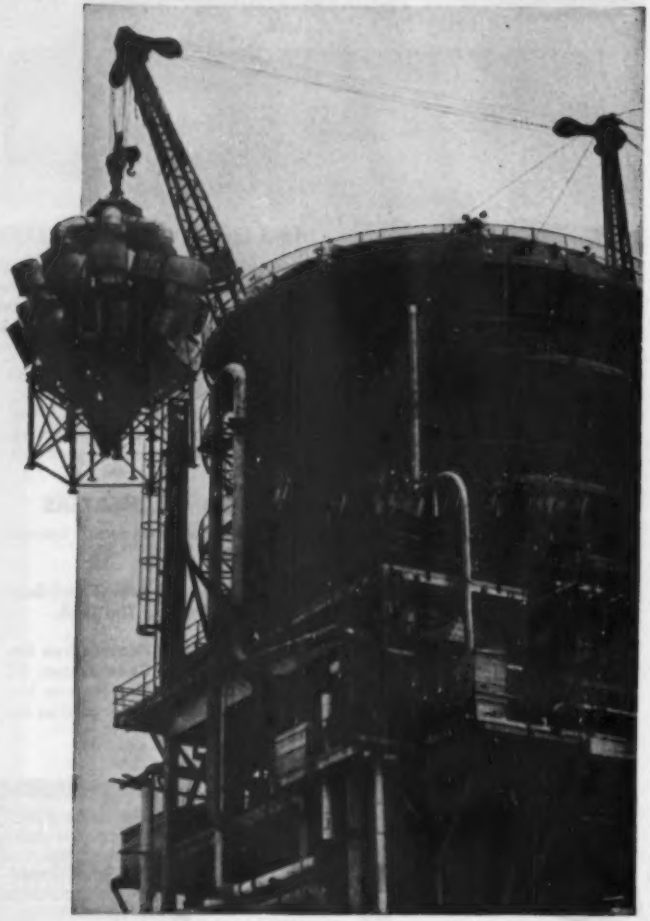

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and C. H. Culnane to The Texas Company.

Hydrocarbons containing an aliphatic chain of at least two C atoms are reacted with H_2S in the vapor phase at a temperature of at least 700° F. over a solid particulate surface-active catalyst, such as an oxide or sulfide of group VI metals. The reaction is continued until the catalyst activity has fallen below 40 percent of the initial activity. The used catalyst is employed for the production of thiophene compounds by the reaction of SO_2 with a hydrocarbon of equal type under similar conditions. The catalyst is thereafter reused for the production of thiophene compounds from such hydrocarbons successively with H_2S and with SO_2.

U.S.P. 2,558,844. Photooxidation of Aliphatic Olefinic Hydrocarbons. V. R. Gray and H. Steiner to Petrocarbon Ltd., London.

An aliphatic mono-olefin with at least three C atoms is reacted in the liquid state with oxygen at a temperature of 0-100° C. while irradiating the reaction mixture with ultraviolet light. Alkenyl hydroperoxides are produced.

U.S.P. 2,559,498. Process for Preparing Resins from Diisobutylene and Cracked Petroleum Condensate. J. D. Garber, W. J. Sparks and D. W. Young to Standard Oil Development Company.

An olefin containing fraction obtained from a compression condensate produced by cracking petroleum at about 1300° F. is used together with diisobutylene for the production of a solid resin, suitable for coatings, by a polymerization in the presence of a dissolved Friedel-Crafts catalyst. Details of the process are claimed.

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,558,206. Process and Apparatus for Drying Hydrogel. B. M. Baird to Phillips Petroleum Company.

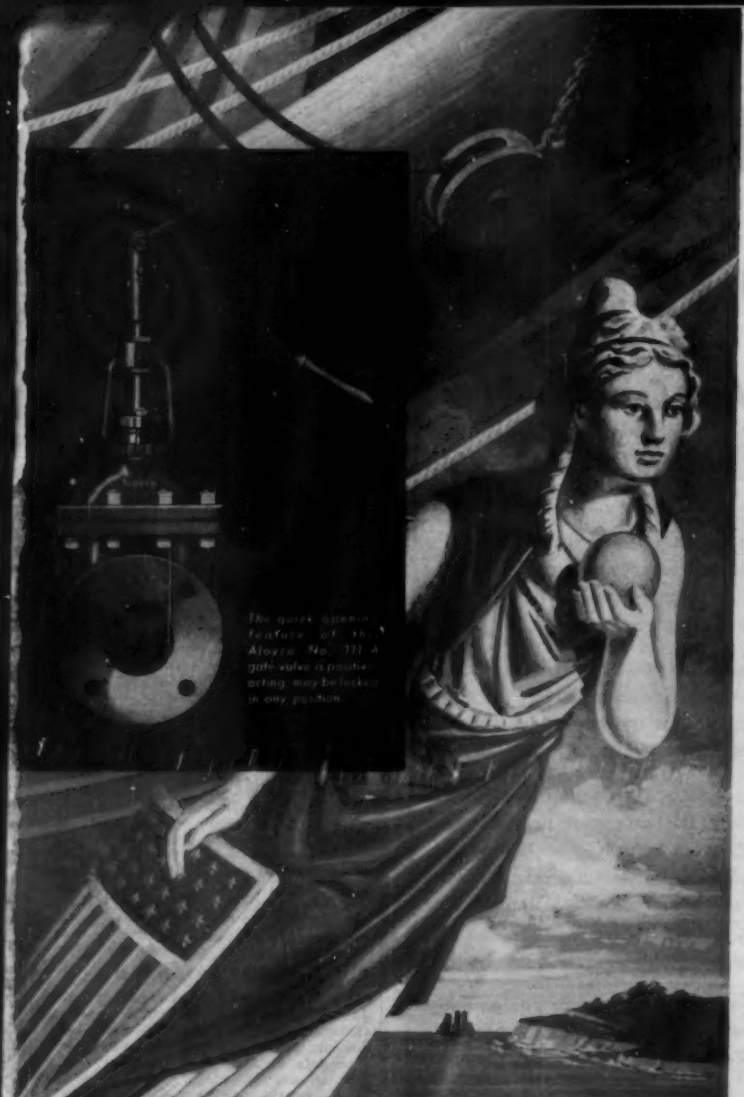
Details are claimed of a method and an apparatus for drying a hydrogel in the production of catalytic materials.

Alloy Casting Institute Expands Research Program

Significant expansion of its technical research program is being undertaken by Alloy Casting Institute to help meet mounting defense mobilization needs and other engineering and equipment requirements dependent on the use of stainless steel castings, E. A. Schoefer, executive secretary, has announced.

In addition to extension of continuing research activities directed toward the improvement of cast alloys widely used in the metals-treating, chemical and many other industries, Schoefer disclosed, three new projects are being instituted.

Battelle Memorial Institute is studying the high temperature properties of the 21-percent chromium, 10-percent nickel type alloy; development of titanium-stabilized corrosion resistant cast-



Lasts longer in corrosive service

This quick-opening gate valve is one of a wide range of ALOYCO valves recommended for severe corrosive services. Its long life expectancy results from ALOYCO's:

A. metallurgical research devoted *exclusively* to corrosive applications;

B. foundry and machine shop facilities set up for high alloy valves *only;*

C. casting and machining practices dictated by the difficult characteristics of the alloys required for corrosive services.

Success Stories from ALOYCO's Corrosion Clinic

THE CORROSIVE: Concentrated sulfuric acid and acid emulsions

THE APPLICATION: Processing high-octane gasoline

THE PLACE: Anglo-Iranian Oil Company, Abadan

THE VALVES: ALOYCO 20 gate valves

THE RESULTS: Alloy-*trimmed* carbon steel valves formerly used had to be removed because of leakage after 8 to 9 months. ALOYCO valves—100% alloy, Teflon-packed at little additional cost, were installed and have completely eliminated this trouble.

Alkylation plant, Abadan Refinery of Anglo-Iranian Oil Co., Ltd., where many ALOYCO valves are installed on highly corrosive services.

THE BACKGROUND: Throughout the petroleum industry it is becoming the practice to combat corrosives with valves made of high alloys . . . rather than to pay the price for frequent replacements, with attendant shutdown.

ALOYCO *concentrates* on the manufacture of such valves. We make no other types. Our foundry practices, our machines and our tools are designed for the production of high alloys alone.

And our *Aloyco Corrosion Clinic* specializes on problems of corrosion, contamination, discoloration, high and low temperature service.

If you have such problems in your plant, put them up to the *Aloyco Corrosion Clinic* for "diagnosis" and "treatment".

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Equipment is hard to replace

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Now more than ever it's important to protect your valuable, hard-to-replace refining equipment against acid corrosion. That's why it pays to use Barrett Standard Anhydrous Ammonia to neutralize acidity in oil refining.

This liquefied gas, guaranteed to be of the highest purity, is one of the lowest cost neutralizing agents delivered to the refinery. One pound will neutralize the same quantity of acid as several pounds of other neutralizing agents.

Easily vaporized, Barrett Standard Anhydrous Ammonia follows the gas stream through the equipment, neutralizing corrosive acids as soon as they are formed. It has high solubility and a high rate of diffusion in oil. It destroys acidity without the formation of water or undesirable emulsions. Products of neutralization are easily eliminated from the oil. Excess ammonia is removed by blowing the oil with air.

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ings is to be investigated at Ohio University while an extensive study of improved gating systems for high alloy casting production will be conducted as part of the ACI program under way at M.I.T.

Acetylene Process Acquired

Chemical Construction Corporation of New York, a unit of American Cyanamid Company, has acquired from Badische Anilin & Soda-Fabrik the exclusive North American rights to use their process for the design and construction of plants which produce acetylene from natural gas.

This process provides for partial oxidation of gas hydrocarbons to furnish a crude acetylene gas. This is then purified to yield acetylene of any desired purity. The "heart" of the process is the use of a selective solvent specially developed for this purpose.

Smog Fight Gain Recorded

Since the beginning of the anti-smog campaign, oil refineries in the Los Angeles area have reduced the amount of sulfur dioxide discharged into the air by about 80 percent, according to Los Angeles County smog control authorities. Sulfur dioxide in the air, the accepted explanation of smog, has been reduced by 50 percent since 1948 alone, according to results obtained from scientific measuring tests. Although smog is usually worse from August to October, smog officials recorded only one day of eye-smarting smog this August.

ACS Society Honors NBS

The Analytical Division of the American Chemical Society recently paid tribute to the National Bureau of Standards when an honor scroll was presented to the Bureau in appreciation of the Bureau's work in chemistry and other fields of science and engineering. The presentation, made by N. H. Furman, president of ACS, to E. U. Condon, Director of NBS, was on the 50th anniversary of the Bureau's establishment.

Oil Compact Extended

President Truman has signed Senate Judicial Resolution 42 which extends the Interstate Oil Compact Commission for four years beyond its present expiration date of August 31, 1951.

Australian Shale Operation Reported by Mines Bureau

Australian operations to produce motor gasoline and allied products on a commercial scale from native oil shale has been reported by two Bureau of Mines technologists, A. J. Kraemer, and H. M. Thorne. According to their report, commercial oil shale development began about 1865, with kerosine, candle wax, and oil for improving the illuminating quality of manufactured gas, the chief products. The early plants were abandoned and are now in ruins.

The Glen Davis plant began operations early in 1940. The shale there is in three seams with a maximum thickness of seven feet, according to the Bureau of Mines report, and at one face only a single two-foot seam is exposed. The mine is operated by the room-and-pillar method, like a mechanized coal mine, and production averages 8½ tons a day per face worker, or three tons per

mine employe. The main seam has a Fischer assay value of about 140 U. S. gallons a short ton and is probably the richest oil shale seam being mined in the world.

"Largest" ISA Instrument Meeting Held in Houston

The Sixth Annual Instrument Conference and Exhibit, scheduled to be held in the Sam Houston Coliseum of Houston, September 10-14, was expected to be the largest and most enthusiastic to date. Arrangement committee chairman J. R. Martin, Humble Oil and Refining Company said the 1951 instrument exhibit was undoubtedly the most inclusive in the history of the industry. The number of exhibit booths laid out just prior to conference time numbered 229; they were reserved by 143 manufacturers, 4 manufacturers' representative companies, one trade association, five cooperating societies, and two educational institutions. In addition the U. S. Navy will occupy ten booths and the National Bureau of Standards, two.

The technical program was formulated cooperatively with a great many national societies. Among them: ASME, AIEE, Institute of Radio Engineers, American Institute of Physics, Texas A. & M. Symposium on Instrumentation for the Process Industries, Gulf Coast Spectroscopic Group, Pipe Liners Club, National Association of Corrosion Engineers, Armed Forces Technical group, etc.

A closed meeting on infrared instrumentation techniques and applications, both military and commercial was scheduled by the Armed Forces September 13. Security clearance is required for attendance at this session. The sessions of September 14 were opened to anyone interested. Papers in this session include a survey on the present status and recent advances in infrared instrumentation, papers on rapid scanning spectrometers, Golay cells and a variety of new commercial infrared equipment.

"Instrumentation for the Process Industries" is the title given the symposium conducted by Texas A. & M. College on September 13 and 14. Another special session was the Instrument Maintenance Clinic, held September 7-9, prior to the conference and exhibit. Initially held in St. Louis in 1949, this third instrument maintenance clinic was planned to comply with preferences expressed at the two previous clinics. The instructors were drawn entirely from instrument manufacture personnel, and ten such manufacturers were represented. These were: Foxboro, Fisher Governor, Republic, Minneapolis-Honeywell, Brown Instrument Division, Manning, Maxwell and Moore, Moore Products, Taylor, Mason-Neilan, Leeds & Northrup, and the Hagan Corporation.

Jones Named First ISA Paid Business Manager

Percy V. Jones, Jr., was named business manager of the Instrument Society of America, effective this month. As the first paid executive director of the association, Jones has established his headquarters in Pittsburgh. For the past four and one-half years he has been associated with the research activities of the American Petroleum Institute in New York City.

Sunray Responds to Scrap Salvage in All-Out Effort

In a company-wide salvage campaign Sunray Oil Corporation has collected and returned to the scrap salvage market more than 820 tons of iron, steel and other metal scrap now vitally needed by the country's defense and business industries.

Sunray's scrap was gathered and turned back into the steel market through sale to local district scrap salvage dealers. The Midcontinent division contributed 160 tons. The company's Allen and Sunray (Duncan), Oklahoma, refineries disposed of 108 tons. The Midcontinent gas-gasoline department collected and disposed of 31 tons and Sunray's West Coast division production, refining, and gasoline departments have disposed of 521 tons of scrap.

By September 1, Sunray field departments expect to collect and dispose of an additional 129 tons from all departments, and will continue the collection effort as long as the national emergency exists.

Vitro Corporation Adds Kellex to Organization

The Kellex Corporation, specialist research and engineering firm, located at 233 Broadway, New York City, has changed its name to Vitro Corporation of America. As the Kellex Corporation, the company was organized January, 1943, as a subsidiary of the M. W. Kellogg Company. It engineered the

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famous gaseous diffusion plant at Oak Ridge, Tennessee, and since the war has designed major production facilities for the atomic plant at Hanford, Washington, as well as other vital projects for the Army, Navy and Air Force. The Vitro Manufacturing Company of Pittsburgh purchased Kellex in June, 1950.

System for Isotope Ratio Determinations Reported

A completely automatic amplifying and recording system for the analysis of gaseous mixtures or isotope ratio determinations by a mass spectrometer was reported at the American Institute of Electrical Engineers Pacific Meeting in Portland, Ore., by Paul S. Goodwin and Robert L. Sink of the Consolidated Engineering Corporation, Pasadena, Calif.

"The mass spectrum of a complex gaseous mixture can be used to obtain the quantitative and qualitative composition of the mixture with the aid of calibration spectra of the pure component constituents," according to the two men.

In discussing isotope ration measurement the authors said: "In studies using stable isotopes as 'tagged molecules' in a chemical or biochemical process, the mass spectrometer has proved to be an accurate and convenient method of measuring the results of such experiments. Simultaneous measurement of the ion current of the more abundant molecule and the rarer isotope is advantageous, since factors which affect the ion currents equally can be cancelled in a rationing process."

Phillips Achieves Million Safety Hours at Borger

Phillips Chemical Company employees in the butadiene section of Plains plant at Borger, Texas, completed one million man-hours without a lost-time accident since December 18, 1950. This is the third outstanding safety accomplishment in the plant's history. On December 24, 1947, this plant completed its first million man-hours without a lost-time injury. This record continued unbroken until February 25, 1948, when one accident resulted in two lost-time injuries. From that date to January 27, 1950, the butadiene section employees worked 3,000,000 consecutive man-hours without a lost-time accident, a first in the history of Phillips plants.

Socony Adds Powerful St. Louis Tug to Fleet

The fastest and most powerful of the Socony inland river towboats and one of the most powerful on the inland waterways, the La Crosse Socony was accepted by the Socony-Vacuum Oil Company on delivery from St. Louis Shipbuilding Company. The hull is 156 feet long, 35 feet wide and eleven deep with a normal draft of eight feet. It is equipped with Kort nozzles and Contraguide rudders as well as other modern improvements.

Pumping Coal by Pipeline To Get Ohio Demonstration

The cost of transporting coal 100 miles by pipeline was estimated to be between $1.28 and $1.91 a ton according to estimates released by Secretary of the In-

IS CORROSION YOUR

AMMONIA
HYDROGEN SULFIDE
CHLORINE
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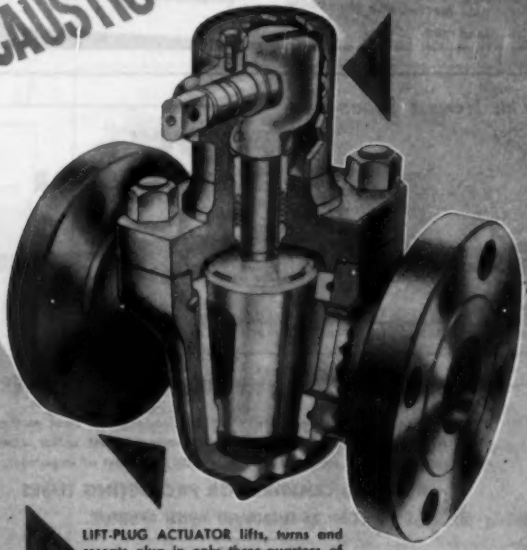

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terior Oscar L. Chapman. He reported a sum of about $10 million would build a pipeline 100 miles long capable of transporting 5000 tons of coal a day with water. Similar initial costs were quoted for larger pipelines. A 36,000 ton-a-day line could be operated for only 38-95 cents per ton per 100 miles, according to Mines figures.

A large Ohio coal company has announced its plan to build a full-scale demonstration pipeline in Ohio, through which finely ground coal will be mixed with water and pumped. The proposed line is to be a twelve-inch pipe, 17000 feet long.

Casper Scene of WPRA Convention, Sept. 20-21

J. W. Sandberg, an engineer from Phillips Petroleum Company, will tell how his company is getting greater product yields from crude, through high-vacuum flashing and radiant heat vis-breaking operations, at a regional meeting of the Western Petroleum Refiners Association in Hotel Henning, Casper, Wyo., September 20-21. His paper, "Application of Radiant Heat to Vis-Breaking and Vacuum Operations," will be in order of a progress report on the performance of the comparatively new radiant type heaters at the Phillips refinery in Borger, Texas.

A fire-fighting demonstration will be staged at the Socony-Vacuum refinery in Casper. A number of actual fires will be started and then extinguished with the newest types of equipment. A fire in a crude tank will be put out, for example, with the new Pyrene Portable Air Foam Tower. This demonstration will mark the first time the tower has been shown in operation in this country.

AGA Annual Scheduled Oct. 15-17 at St. Louis

At the thirty-third Annual Convention of the American Gas Association being held in St. Louis on October 15-17, the important subjects to be discussed before more than 5000 delegates expected to attend, will cover natural gas expansion, utility financing, public relations, and Federal controls. The panel of speakers will be headed by Senator Everett M. Dirksen of Illinois.

D. A. Hulcy, Dallas, who is president of both the AGA and the U. S. Chamber of Commerce, is slated to open the convention with an address on the prospects and accomplishments of the gas industry. Senator Dirksen will speak Wednesday, October 17, on "Citizens' Responsibility."

Coastal Engineering Men Slate November Meeting

The second conference on coastal engineering will be sponsored by the Southwest Research Institute of San Antonio, Texas, and is scheduled to be held at the Rice Hotel, Houston, on November 7-10. Cooperating to present the conference are the University of California, Texas A. & M. Research Foundation, The Rice Institute, University of Houston, and the Houston branch of the ASCE.

The purpose of this institute is to summarize current information and techniques for engineers engaged in the design, construction, operation, and maintenance of coastal works. Charles

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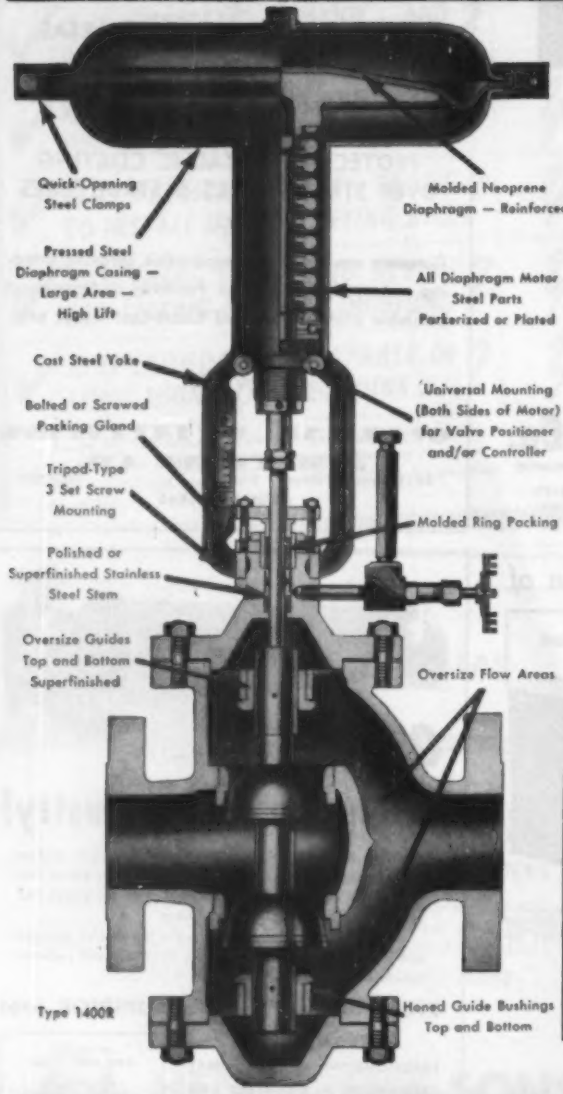
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E. Balleisen, conference secretary, is in charge of information and program arrangements.

100 Insulation Engineers Organize in Philadelphia

One hundred engineers interested in heat insulation met at the Franklin Institute of Philadelphia and organized "The Thermal Insulation Society"; W. H. Zane, duPont Company engineer and vice chairman of the ASTM C-16 committee on insulation specifications, was elected the first president. The group meets once a month at Franklin Institute to discuss common problems and to hear speakers on some specific insulation material.

Purpose of the organization is to accumulate information for insulation specifications, and to promote a better understanding between manufacturer, applicator, and final consumer.

Aluminum Ore to Increase Production by 70 Percent

Plans for increasing the nation's alumina producing capacity by 180,000 tons annually through the addition of new production facilities at an existing plant in Mobile, Ala., were revealed by Aluminum Ore Company president, Allen B. Williams, who announced a forthcoming construction program.

The company is already erecting a new alumina works at Bauxite, Ark., in addition to operating plants at Mobile and at East St. Louis, Ill. This expansion will boost Aluminum Ore Company's production capacity by approximately 70 percent when completed. Construction at Mobile is scheduled to begin soon, and production of alumina is expected to start by late 1952.

Alcoa Adding New Research Building at New Kensington

As part of its program for research expansion Aluminum Company of America is erecting a new building at its Aluminum Research Laboratories at New Kensington, Pa. The new unit is needed to relieve congestion and to extend ALCOA's research facilities to meet increasing demands of the national defense program. It will increase total floor space at the laboratories by about one-third. Construction is already under way, and the building will be ready for occupancy early next year.

The new addition will consist of two bays, one of which will be three stories high, the other two stories. A six-ton mill-type crane will be installed in the first bay to handle heavy research equipment.

Sinclair to Build Tankers

Bethlehem Steel Corporation will build two ocean-going tankers for Sinclair Refining Company according to a recent announcement. The vessels will be 600 feet long, 78 feet wide, and will have a cargo capacity of 210,000 barrels of gasoline or 175,000 barrels of crude oil.

Newspapers Receive Ads For Oil Progress Week

An eight page proof book containing 30 suggested advertisements for use during Oil Progress Week will be distributed by the Oil Industry Information Committee for this year's observance,

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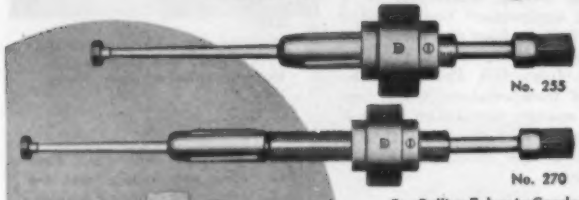

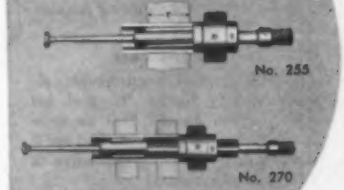

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October 14-20. A similar tie-in advertising kit last year resulted in the publication of more than 4 million lines of local advertising during Oil Progress Week. The 1951 proof book will be sent to every daily and weekly newspaper in the country. The ads will be provided in all sizes and are written specifically for various aspects of the industry.

Incentives Needed for Brazilian Oil Development

A more constructive attitude toward foreign capital and the enactment of favorable legislation designed to attract the best efforts of the competitive oil industry would go far toward minimizing the risk of Brazil's industrial growth being retarded in the event of a change in the conditions upon which that country's oil imports depend. This statement is made by Joseph E. Pogue, petroleum consultant to The Chase National Bank, in a 32-page booklet, "Oil In Brazil," released by the bank recently.

During 1950, Brazil produced only one percent and refined only four percent of its annual petroleum requirements of some 91,500 barrels per day. The oil imports are paid for by exports of coffee, cotton, and cacao. A continued expansion of oil consumption, an ultimate rise in world oil prices, and an arrested trend in market prices of coffee and other exported commodities would bring about a lessened availability of exchange relative to the augmented requirements for oil imports.

Pogue believes the trend to oil in Brazil is inevitable. Alternate sources of energy such as wood, coal and water are either inadequate or uneconomic. Oil consumption has been bolstered by a steady population growth, the rapid industrialization of Brazil's "Heartland," and growing imports of machinery and automotive equipment. As a user of petroleum, Brazil now ranks sixth in the Western Hemisphere. Its petroleum requirements increased by 19 percent in 1949 and 21 percent in 1950.

While the 1946 Constitution of Brazil limited exploration and development of oil to Brazilians and Brazilian companies, it did not stipulate that only Brazilians could be shareholders of such companies as did the 1937 Constitution and the 1940 Mining Law and the 1941 Oil Law. However, the government has not enacted legislation implementing the 1946 Constitution in regard to oil.

"Obviously," Pogue declares, "Congressional action is needed to bring the laws up to date and in harmony with the constitution. For the active development of the Brazilian petroleum industry, the best solution would be the passage of a sound and modern general petroleum law which would open the door to free competition by both Brazilian and foreign companies on terms attractive both to the government and to the contractors. At least two attempts have been made to draw up such a law, but no action has been taken."

Adequate incentive and competition are peculiarly essential in the search for oil, according to Pogue. Where competition has not operated, little oil has been found in the world. Many countries have attempted to develop oil through a medium of an arm of the state, but the results attained by this method have not been conspicuously successful. Outside of the United States, the bulk of achievement in the field of petroleum has been made by so-called international oil com-

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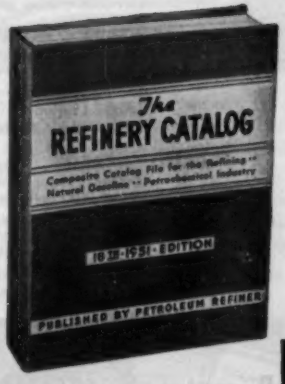
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panies, which are massive aggregates of capital and technology, performing an integrated series of functions. Experience shows this form of organized effort represents the most direct avenue of achievement in this difficult field. Pogue cites Venezuela and Canada, both enjoying vigorous and healthy oil economies, in contrast to Brazil which has not seen fit to entrust the development of its oil resources to private enterprise.

According to Mr. Pogue, the existence of a substantial petroleum resource in Brazil is purely a matter of geologic inference. At present oil is being produced only in the relatively small Bahia Basin on the East coast of Brazil, which has aggregate reserves of an estimated 25 to 50 million barrels. Geological surveys have located half a dozen immense sedimentary basins, comprising more than 750,000 square miles, of a type that might yield oil. However, the sediments are too thinly developed to constitute what is generally regarded as first class prospects. "Incentives," Pogue says, "should be especially powerful and clearly assured to offset the augmented risks of wildcatting against long odds."

A strong trend toward local refining is underway in Brazil in a mixture of government and private undertakings. In addition to some enlarging of present refineries, four others are in the process of construction or in the planning stage. Pogue thinks that a rapid building of a refining capacity equal to consumption may result in duplication elsewhere and may lead to operating costs discouraging in the long run to the attainment of a corresponding balance in crude oil production.

In the meantime, Pogue advocates a continued growth of oil consumption in Brazil, based upon maximum use of existing facilities, whether domestic or foreign. Such a policy would create the time required to bring about adequate exploration of local sources of supply and help attract the funds for financing the effort without undue burden on the local economy.

Whitman Named Head of Research-Development

Walter G. Whitman, head of the Chemical Engineering Department at Massachusetts Institute of Technology, has been named chairman of the Defense Department's Research and Development Board. Whitman, a former associate director of research for Standard Oil Company (Indiana), had served on the Fuels and Lubricants Committee of Research Board since 1949 and was chairman of the subcommittee on Aircraft Fuels and Lubricants of the National Advisory Committee for Aeronautics.

Scale Model Coal-Water Pipeline Built in Ohio

A full scale twelve-inch demonstration pipe line which Pittsburgh Consolidation Coal Company is now building at Georgetown, Ohio, is expected to be completed and in operation late this Fall, according to Joseph Pursglove, Jr., vice president in charge of research. The pipe line is being constructed to study the commercial aspects of moving a coal-water mixture. If the test proves successful, the company plans a commercial line from its strip mining operations at Georgetown, to Cleveland, 200 miles.

Gallaway Again Heads Industrial Safety Group

The Industrial Safety Equipment Association recently re-elected Charles H. Gallaway of American Optical Company as president.

Elected to the vice presidency was Earl H. Brooks of Safety Clothing and Equipment Company. Jess A. Brewer, Industrial Gloves Company and G. M. Glidden, Acme Protection Equipment Company, were elected trustees.

Carrying over as trustees are Frank R. Davis, Jr., Davis Emergency Equipment Company and Stanley C. Herbine, Willson Products Company. Lawrence E. Dickson, junior past president, automatically continues as a board member for another year.

Construction

(Other Notes on page 91)

Cosden and Roosevelt Plan UDEX Unit Installations

New UDEX process units, recently developed by Dow Chemical Company and Universal Oil Products Company, to separate benzene and toluene from other hydrocarbons will be installed by both Cosden Petroleum Corporation and Roosevelt Oil & Refining Company.

The Cosden installation will be a 1500-barrel-a-day unit at its Big Spring, Texas, refinery as part of an expansion program begun last spring. Roosevelt will add a 1100 barrel unit at Mr. Pleasant, Mich., where the company is also installing a 1900-barrel UOP Platforming unit and a 450-barrel aromatic treating unit.

Construction on the projects is slated to begin in October, with completion scheduled for next summer. UOP is doing the design and engineering work for both projects, with construction being handled by Procon, Inc.

Roosevelt Facilities for Benzene Being Constructed

Roosevelt Oil & Refining Company has begun construction of benzene facilities at Mt. Pleasant, Mich., at a cost of over $1.5 million. A catalytic reformer to be installed will process 1380 barrels daily of straight-run naphtha and will cost about $894,000. The aromatic facilities, which are designed to process 214 barrels of benzene and 224 barrels of toluene daily, are estimated to cost over $650,600. The project is scheduled for completion July, 1952.

Stanlow Refinery to Have Sulfur Recovery Plant

Shell's Stanlow refinery in England will soon have a unit to convert hydrogen sulfide into elemental sulfur and thus assist in the over-all economy of the United Kingdom, officials have announced.

The sulfur plant will recover 10,000 tons yearly from the hydrogen sulfide derived from cracking Middle East crudes. In addition, an acid plant is being installed to convert waste sulfuric acid sludge to fresh acid. The acid plant is designed to take in 5000 tons of Shell's own produced sulfur concurrently with

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the sludge acid, and the resultant total production of sulfuric acid can fulfill all Stanlow's acid requirements including those for synthetic chemicals, lubricating oil additives, transformer oils and the like.

However, as long as elemental sulfur continues in short supply in the United Kingdom, this sulfur can be released to domestic users, officials pointed out. To facilitate the release of elemental sulfur, Shell's acid requirements will, so far as possible, be obtained from outside sources which use less critical raw materials than sulfur.

The total cost of these projects is estimated at $1.4 to $1.7 million and essentially all the equipment used in their construction will be of British manufacture. Both the sulfur recovery plant and the acid plant, while conventional in principle, have many modifications which make them most modern. The sulfur recovery plant will commence operation at the end of this year concurrently with the initial operation of the catalytic cracking plant. The acid plant will be commissioned in the latter half of 1952.

Sulfur Plant Projected Near Louisiana Discovery

Discovery of a large new deposit of sulfur at the mouth of the Mississippi River was announced last month by Freeport Sulphur Company which will erect a $10 to $15 million mining plant having a production goal of 500,000 long tons of sulfur a year. The mine, which will be the largest single sulfur development anywhere in the world in nearly 20 years, is expected to be in operation in 1953. The deposit is located in Garden Island Bay, in the marshes of the lower Mississippi River delta 100 miles southeast of New Orleans.

The deposit is native sulfur, or brimstone, the cheapest and purest of sulfur forms. The dome was discovered by The Texas Company in exploring for oil which is being produced from the flanks of the formation. Freeport holds the sulfur rights and under its lease will pay Texaco 50 percent of the profits derived from the operation.

California Standard Will Add Detergent Alkane Unit

Plans for a $1.5 million expansion of facilities at its Richmond refinery for production of synthetic detergent materials were announced by Standard Oil Company of California for its subsidiary Oronite Chemical Company. Added capacity to make detergent alkane to meet present and future needs of the soap and synthetic detergent industries will be provided for the chemical company. Detergent alkane is used largely in the manufacture of synthetic detergents for the household market.

Japanese Project Listed

California Texas Oil Corporation will invest $18.5 million in oil refinery equipment in Japan according to a report by Yaichi Sasaki, president of the Japan Petroleum Company. The investment will be in addition to its other investments already announced jointly with the Japan Petroleum for the installation of a new Japanese refinery.

About EQUIPMENT and SERVICE Suppliers

Gerbereux Named Manager of Worthington Pump Sales

V. de P. Gerbereux, appointed manager of the Centrifugal Pump Sales Division of Worthington Pump and Machinery Corporation, succeeds A. H. Borchardt who was recently elected vice president in charge of centrifugal, reciprocating and vertical turbine pump sales.

Gerbereux

Gerbereux is a mechanical engineering graduate of Cornell University and completed the Worthington Student Training Course in 1924. He was assigned successively as centrifugal pump designer, application engineer and assistant manager of the Centrifugal Pump Sales Division.

Inventor of a specific speed slide rule and an acid valve, he also is the author of the centrifugal pump section of Kent's Handbook. Gerbereux makes his home in Upper Montclair, N. J.

Barnes, Shasta Pumps, Merge; Will Manufacture Both Lines

Purchase of a West Coast pump manufacturing plant by Barnes Manufacturing Company of Mansfield, Ohio, involves the purchase of all the assets of the Shasta Pump Company located in Oakland, Calif. Shasta Pump, merged and renamed Barnes-Shasta Pump Company, will operate as a wholly owned subsidiary manufacturing the complete line of Barnes pumps for distribution on the West Coast. The Shasta line of products will continue to be manufactured in Oakland.

G. E. Appoints James Goss Divisional Staff Assistant

James H. Goss, appointed staff assistant to Nicholas M. DuChemin, general manager of General Electric's Small Apparatus Division, was formerly manager of engineering of the Control Divisions at Schenectady, N. Y., since 1947. Goss will make his new headquarters at Lynn, Mass.

Goss joined G. E. in 1931 as a student engineer and later was assigned to the West Lynn (Mass.) Works Laboratory. He was appointed engineer in charge of the laboratory in 1936 and assistant to the works engineer in 1946. Goss is a graduate of the University of Arkansas.

B&W Expands Sales, Plants

New sales headquarters in Los Angeles have been opened by The Babcock & Wilcox Tube Company of Beaver Falls, Pa. The expanded Pacific Coast office is located in the Lawson-Chipman Building on Wilshire Boulevard. H. F. Lefferty, Pacific Coast manager said the expansion affects the Beaver Falls and Alliance, Ohio, plants as well. Babcock & Wilcox are expanding in anticipation of accelerated aircraft, atomic energy, petroleum refining, etc., activity, according to company statements.

Duraloy Appoints Zinss

The Duraloy Company, Scottdale, Pa., manufacturers of high alloy castings, appointed J. W. Zinss as general manager of operations. Zinss was formerly assistant to A. M. Miller, who has been transferred to the Detroit office. Harry Robbins has been named as assistant to Zinss.

Griscom-Russel Building New General Offices in Ohio

Griscom-Russel Company moved its general offices from New York City to the company plant in Massillon, Ohio. The move was made to centralize the administration, general sales, engineering, development and other departments for more efficient operations and service "in the interests of national defense." A

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new office building is being erected opposite the Massillon station of the main line of the Pennsylvania Railroad. The New York office will continue to operate as one of the 25 district sales offices.

Gustin-Bacon Cleans Up, Carries On, After Flood

Gustin-Bacon Manufacturing Company of Kansas City, has returned to almost normal production following a devastating flood that hit that area July 13th. The first floors of all seven of the company plants in greater Kansas City were inundated by the rampaging waters but fortunately finished goods inventories were stored on higher floors. Round the clock clean-up work has returned all plants to full or at least limited production.

Rockwell Appoints Sells New Orleans Office Manager

J. H. Sells has been named to succeed M. F. Groom as head of Rockwell Manufacturing Company's New Orleans' office. A graduate of Texas A. & M., Sells was formerly employed by Shell Oil Company. He joined Rockwell three years ago and since that time has been handling the sale of all products in the Alexandria, La., vicinity. As manager of the New Orleans office he will cover the New Orleans and Baton Rouge areas.

Schofield Awarded Plaque By Leeds-Northrup for Service

W. Richison Schofield of The Barclay, Pa., a vice president of Leeds & Northrup Company, was awarded a Leeds & Northrup 35-year plaque in official recognition of his long service to the company. He joined the company in 1916 as a 20-year old draftsman. An electrical engineering graduate of the University of Pennsylvania, he has worked as designer and engineer, as a member of the executive committee and various executive offices. Schofield is a widely known authority on temperature recording and controlling instruments.

Long

Tysenn

Kaylo Assigns Long to Toledo; Tysenn to Philadelphia Sales

Kaylo Division of Owens-Illinois Glass Company recently assigned Robert P. Long as insulation engineer for Heat Insulation Sales, and Anthony J. Tysenn as sales engineer in the Philadelphia office

Long, an electrical engineering graduate of Carnegie Institute of Technology, formerly was sales manager of H. H. Buggie and G. L. Hoskin Companies, Toledo, and field engineer of Gulf Oil Company at Port Arthur, Texas. He will make his headquarters at Toledo.

Tysenn recently completed a company training schedule that included study at the Toledo and Philadelphia offices and at the Berlin and Sayreville, N. J. plants. A marketing graduate of the University of Pennsylvania, he was formerly employed by Rohm & Haas Chemical Company.

Worthington Modernization At Oil City Plant Begun

A $500,000 modernization of Worthington Pump and Machinery Corporation's Oil City, Pa., plant is underway. Plans include re-equipping the present foundry and establishing a new electric power supply, according to company reports. Sorbo-Mat Process Engineers, foundry specialists of St. Louis, have been retained to make foundry layouts and develop a method of making castings which is known as "innoculation."

Mechanization includes installation of overhead crane service at all working stations and 500 feet of roller conveyors, as well as new molding machines, sand conditioning and sand supply equipment, and new mold drying ovens.

Graver Appoints Three New District Sales Managers

Graver Water Conditioning Company, manufacturers of equipment for all water treating processes, appointed Harold R. Fosnot Eastern Sales Manager with headquarters at the company's home office, 216 West 14th Street, New York, and effected Chicago and Cleveland personnel changes also. Fosnot, formerly Chicago district manager and graduate of Purdue University and the University

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of Chicago, is a licensed professional engineer in Illinois. Since 1937 he had worked extensively in the industrial and municipal water treatment field throughout the Chicago district.

Replacing Fosnot at the Chicago headquarters will be Herman M. Ross, previously the Cleveland district manager. He received a Civil Engineering degree in 1937 from the Illinois Institute of Technology and was the Chief Sanitary Engineer for the U. S. Army's Seventh Service Command Sanitary Corps during World War II.

In Cleveland, Graver will now be represented by Richard E. Lewis, a chemical engineering graduate of New York University, who was previously in the Graver home office at New York. Lewis' Cleveland headquarters are in the Hippodrome Building.

DevicEngineering to Represent Rochester Dial Thermometers

DevicEngineering will represent Rochester Manufacturing Company in the sale of Dial Thermometers in eastern Pennsylvania, southern New Jersey and Delaware, according to a recent announcement. DevicEngineering, 1701 Walnut Street, Philadelphia, is headed by William A. Diament, formerly vice president and sales manager of Fischer & Porter Company, Hatboro, Pa.

Pentek Research Facilities Enlarged by Heyden Chemicals

Heyden Chemical Corporation completed plans for construction of a series of new laboratory units at its Chemical Research Division, Garfield, N. J. Research facilities will be increased by 30 percent. The first new laboratory unit, now under construction, is scheduled for completion in the last quarter of 1951.

Major factor in the expansion is a broad program to develop new applications of Pentek and other pentaerythritol derivatives which are used as the base for the new quick drying, weather resistant paints specified for navy ships, army tanks, jeeps, bombs and other defense uses.

Williams Joins John Green As Sales Engineering Agent

Bruce M. Williams joined the John A. Green Company of Dallas this month. Engaged as a sales engineer, he will call on industrial accounts, jobbers, research laboratories and manufacturers in the states of Texas, Oklahoma, Louisiana, Arkansas, and New Mexico. The John A. Green Company is Sales Engineering Representative for several nationally known manufacturers of test instruments, complete electrical equipment and quality component parts.

Williams

Williams is an associate member of IRE, AIEE, and ARRL. A graduate of the University of Cincinnati, he received his M.S. degree from Oklahoma A. & M. College. He taught electrical engineering at A. & M. for two years and then did research engineering for the Magnolia Petroleum Company at Dallas.

G-E Offers Maintenance Plan To Cut Lost Production Time

Vital assistance and planning are offered by General Electric in a program termed "Productive Maintenance." Aimed at minimizing lost production time and forced idleness due to equipment failures, the program also provides for better spare parts control, smoother production flow, and enables industry to gain optimum output from existing equipment, according to H. F. McCullough and H. D. Beale, G-E engineers.

The G-E plan recommends five remedial measures, offers the maintenance engineer a productive maintenance kit for setting up a working program, makes available a slidefilm on the benefits of productive maintenance, and in addition, offers to send G-E service engineers to assist in making complete equipment surveys to determine existing conditions, future outages, and to guide in setting-up a working spare parts control.

Oilwell Names Clarence Craft To Manage Borger, Texas, Store

Clarence E. Craft, long time employe of Oil Well Supply Company, has been named manager of the branch store at Borger, Texas. Prior to promotion he was district material supervisor at Harvey, La. Craft, who attended both John Tarleton College and the University of Houston, joined "Oilwell" in 1936. He has served as warehouseman in South Texas and Louisiana, as storeman at Mission, Texas, and warehouse supervisor and field representative at Alice, Texas. A native of Beaumont, Texas, Craft has been at Harvey since 1949. The company is a subsidiary of U. S. Steel Corporation.

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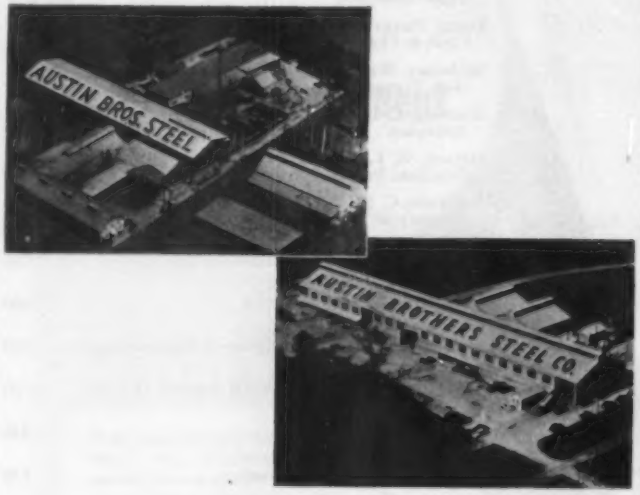

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Hanley Heads Pittsburgh Office Opened by Clark Bros.

Opening of sales and service offices in Pittsburgh was announced by Clark Bros. Company, Inc., from its main Olean, N. Y., plant. The Pittsburgh offices will be located at 2920 Koppers Building and they will be headed by Sidney S. Hanley, newly named district manager. Formerly Hanley assisted William H. Bendeau out of the Olean plant. Prior to field experience, Hanley worked in Technical Sales on specialized projects. He is a William and Mary College and M.I.T. graduate.

Bendeau after 36 years service will continue as a consultant out of the home office at Olean.

Another member of the Pittsburgh office will be James D. Gilbride. A cornell University graduate, he has had a great deal of experience dealing in both centrifugal and reciprocating compressor projects.

Robert T. Nelson, experienced in Clark Balanced/Opposed Motor Driven industrial compressors, will also join the Pittsburgh complement. Nelson is an R. I. T. graduate.

Adds Pennsylvania Branch

Worthington Pump and Machinery Corporation of Harrison, N. J., has opened a branch office in Harrisburg, Pa. The new office at 506 Hall Building, will be in charge of A. L. Mays and will be a branch of Worthington's Philadelphia office.

G-E Names Dunn Manager Michigan Apparatus District

General Electric has appointed Clifford M. Dunn manager of the Michigan Apparatus district. Dunn succeeds Arthur R. Hines, who has been appointed assistant manager of marketing for the company. Dunn's headquarters will be in Detroit although the district comprises most of the state of Michigan.

A graduate of Washington University, St. Louis, he was a G-E sales representative in the Midwest from 1932 to 1946 when he was made sales engineer in the Detroit office. He was appointed assistant manager of the office in 1948.

Asbestone Sees Sales Volume In St. Louis Residential Area

Formal opening of a new branch plant in St. Louis by Asbestone Corporation is the most recent step in the aggressive expansion program inaugurated by the firm's executives, Clifford F. Favrot, and Paul G. Charbonnet. The new $1 million plant on St. Cyr Road will manufacture Asbestone siding shingles and wallboard. Asbestone executives foresee great sales volume in this residential field. Thirty years in business, the firm started out while manufacturing only corrugated roofing and siding.

Fallon to Open Columbus

Joseph Fallon of the General Controls Company office in Cincinnati has been appointed factory branch office manager for the firm's new location in Columbus, Ohio. Fallon formerly was in charge of the Cincinnati, Ohio, office. The move is being made to bring sales representatives in closer contact with outlets in central Ohio, according to company officials.

Fallon

Fallon is a graduate of the University of Cincinnati and is a registered engi-

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neer in Ohio. He is affiliated with the Refrigeration Service Engineering Society and the Engineering Society of Cincinnati.

Heyden to Move Five Offices

Heyden Chemical Corporation has leased the 16th floor of the Canadian Pacific Building at 342 Madison Avenue, N. Y., for occupancy by its executive staff and as headquarters for the sales offices of its subsidiary, the American Plastics Corporation. The move will not be made until early in 1952. The Heyden Medical Department, Market Development, Technical Sales and Advertising departments will also use this address.

Officials of General Controls and Grayson-Greenamyer after negotiations. See item below picture.

General Controls Names Safford Buys Out Grayson-Greenamyer

Handshakes all around completed General Control Company's purchase of the assets of Grayson-Greenamyer, Inc., of Monrovia, Calif. Richard Grayson, left, former president of Grayson-Greenamyer, looks on as William Ray, second from right and president of General Controls Company, shakes hands with John H. Grayson. Other onlookers are J. F. Ray, background, General Controls vice president, and George Greenamyer, right. Richard Grayson will take over as general manager of the newly-formed Grayson-Greenamyer Appliance Controls Division plant; Greenamyer was appointed works manager and John Grayson will be retained as director of research and development.

Henry B. Safford, Jr., has been appointed advertising and sales promotion manager of the General Controls Company. A 1938 graduate of Dartmouth College, his primary duty will be to oversee, produce and originate silent sales aids to augment the field work done by sales representatives of the Glendale, Calif., firm.

Leroy Donald and Goldthwaite Head Lion Oil Chemical Sales

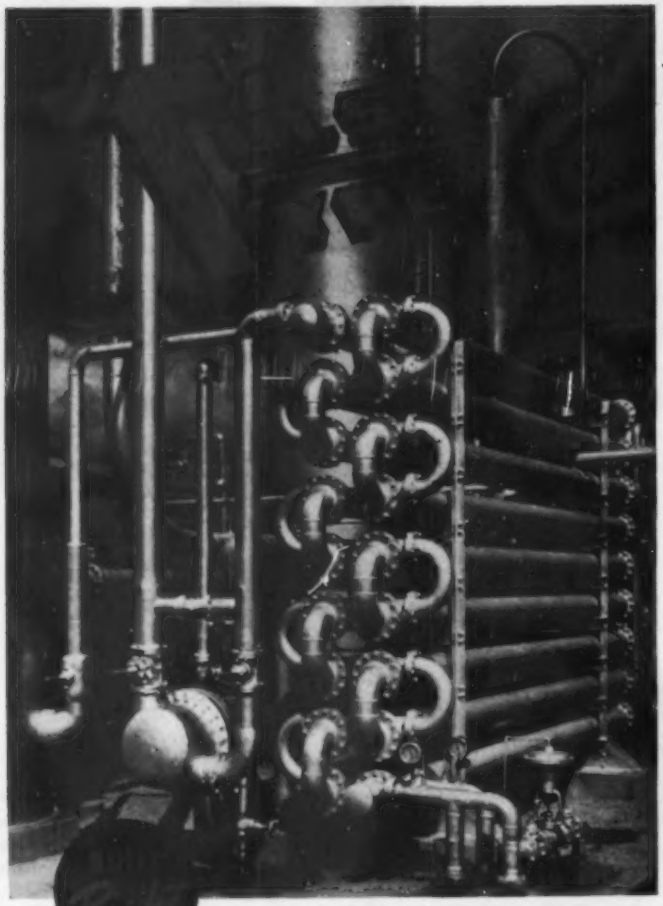
Lion Oil Company appointed Leroy Donald to the newly created position of sales manager for the Chemical Division. Donald joined Lion in 1948 as chief agronomist and has been administrative assistant in chemical sales since 1949.

In addition, Richard W. Goldthwaite was named an assistant sales manager of the Chemical Division. Originally employed by Lion Oil in 1947 as sales representative, Goldthwaite has been sales manager for the company's western division since early 1951.

George C. Cook, manager of the sales analyst department will assume the added duties of administrative assistant to the vice-president in chemical sales.

Furnace Manufacturer Moves

The Petro-Chem Development Company will move to new quarters in the Chanin Building, 122 East 42 Street, New York, in November. The Petro-Chem Development Company engineers and erects furnaces and superheaters used in the refining and chemical industries. Among their products are the Iso-Flow Furnaces and Superheaters. They will be located at their old address, at 120 East 41 Street, through October.



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Struble

Mowry

Struble Elected Purchasing Officer for American Meter

American Meter Company, Inc., recently elected D. Clark Struble to be vice president in charge of purchasing, and appointed E. J. Mowry personnel director for the company.

Struble joined the company in 1928 at the Erie, Pa., plant in the production and stores department. He was named manager of the Production Control Section in 1946, and in this capacity served as general purchasing agent for the company.

Mowry, a graduate of the University of Pennsylvania, joined American Meter in 1937 after being employed by Westinghouse Electric Company in Philadelphia. Prior to his recent appointment he served in the accounting department as plant personnel director.

National Tube Company Opens Testing Lab at Pittsburgh

Laboratory facilities to test materials and to conduct extensive research into metallurgical problems have been opened by National Tube Company at 327 Craft Avenue in Pittsburgh.

The third floor of the laboratory contains electronic measuring devices, a photoelastic stress analysis laboratory, oscillographs, magnetic detectors and a photoelastic analysis laboratory to determine three-dimensional stresses that occur in pipe joints and threaded unions.

Conference rooms, a research library, a creep-test laboratory and equipment for testing hardness of steel products are on the second floor. The street floor contains a machine shop, chemistry laboratory and fatigue testing machines, while equipment for testing full-size equipment is located in the basement.

G-E Appoints Edwin Howell East Central District Manager

Edwin H Howell was appointed manager of the East Central district of General Electric Company's Apparatus Marketing Division this month. His headquarters in Cleveland will take care of the district including most of Ohio, Indiana and Kentucky. After graduating from Georgia School of Technology in 1922, Howell joined G-E as a student engineer, later transferring to Pittsfield, Mass., for sales training. Howell has served G-E in New York, Dallas, Cleveland, Cincinnati, Memphis, Toledo and Washington, D. C.

MD Names Houston Outlet

Metals Disintegrating Company, Inc., Elizabeth, N. J., appointed The Roy A. Ribelin Distributing Company of Houston, Texas, as distributor for MD Aluminum pastes and powders and gold bronze powders in southeastern Texas.

C. M. Buhler, Jr., manager of Ribelin's Houston office will be in charge of MD service for metal pigments and will assist in metal pigment application problems.

Wheelco Establishes In Canada

Wheelco Instruments of Canada, Ltd., will handle Canadian operations for the Wheelco Instruments Company of Chicago. The Canadian firm is a new subsidiary whose corporate officers are: R. A. Schoenfeld, president; Francis Beaupre, vice president-secretary; and E. J. Stevenson, vice president-treasurer.

The new company is under the direction of Beaupre who has been in charge of Wheelco's Toronto District office for the past four years.

Allis-Chalmers Elects Two Directors, Vice-President

Allis-Chalmers Manufacturing Company recently named two new directors and a new vice president. J. L. Singleton and R. S. Stevenson were named board directors, while W. E. Hawkinson was named a vice president.

Singleton graduated from Alabama Polytechnic Institute and immediately entered Allis-Chalmers graduate training course in 1926. He was named a vice president and director of sales for the general machinery division in 1947, and vice president in charge of the division early this year.

Stevenson, a graduate of Washington State College, joined Allis-Chalmers in 1933 as a salesman in the Kansas City tractor branch office. He was named

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vice president in charge of the tractor division early this year.

Hawkinson joined the company at the age of 15 as a messenger boy. He worked up to credit department clerk, then was placed in charge of credits and collections. Subsequently he was named assistant manager of the tractor division. He became treasurer of the company in 1936, and was named secretary and treasurer in 1941.

Branson Instruments Relocated

Branson Instruments, Inc., moved to new plant facilities at 430 Fairfield Avenue, Stamford, Conn. The new building has twice the floor space of the previous location, and will enable the company to expand its production of ultrasonic thickness gages, flaw detectors, and other electro-mechanical devices.

Robbins

Lawler

Robbins, Lawler Appointed Shell District Managers

J. J. Lawler, manager of Shell Chemical Corporation's St. Louis district office, was appointed manager of the Chicago district office. He will be succeeded at St. Louis by James K. Robbins, Jr.

Lawler, a Shell employe for the past 14 years, has been engaged in administrative and sales capacities in Shell Oil Company and Shell Chemical Corporation since graduation from the University of Missouri in 1937.

Robbins, a native of Missouri, attended St. Louis and Chicago Universities and has been engaged in chemical sales for more than 15 years. His duties will involve marketing organic chemical products.

Dr. Rader Named to G. E. Control Division; Appoints Two

Dr. Louis T. Rader, who was appointed manager of engineering of General Electric's Control Divisions at Schenectady, N. Y., immediately appointed Harry L. Palmer his assistant, and named Benjamin Cooper as division engineer of the Electronics and Regulator Engineering Division.

Dr. Rader is an electrical engineering graduate of the University of British Columbia and of California Institute of Technology. Joining G. E. in 1937 as a student engineer, he subsequently was employed as design engineer, division engineer, assistant to the manager of engineering for the divisions, and assistant manager of engineering of the Control Divisions.

Palmer, division engineer of the Control Division's Electronics and Regulator Engineering Division since 1948, graduated from Washington State College. He joined G. E. in 1925 as a student engineer and was assigned to vacuum tube application development in Radio Engineering Division.

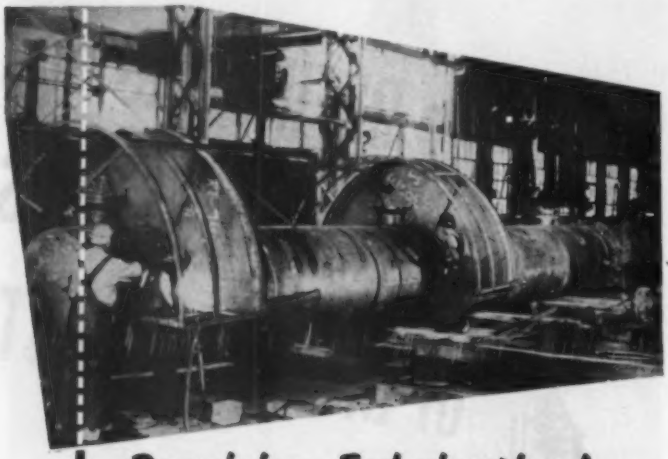
Following graduation from Swarthmore College in 1937, Cooper joined G. E. as a student engineer and later worked on special projects in the electronic control section. A line engineer in that group for three years, he has also been assigned as section engineer and assistant division engineer.

Rainey Company Represents Otto H. York Equipment

Otto H. York, president of the Otto H. York Company, Inc., process equipment manufacturers and engineers, appointed The Rainey Company of Houston as sales engineers for the south-central region. Under direction of John B. Rainey, the newly appointed company will handle regional sales and engineering for the York line of wire mesh entrainment separators and mist extractors; the Scheibel-York multi-stage liquid-liquid extraction equipment for performing precise separations; the compressed wire barriers, filters and strainers used in the petroleum and allied industries.

National Tube Promotes Fader To General Superintendent

William L. Fader was appointed general superintendent at Christy Park Works for National Tube Company, a subsidiary of U. S. Steel. Fader succeeds Arthur C. Landis, who died recently. Fader started with National Tube in October, 1950, as superintendent of the shell forge department at the Christy Park plant. He has been assistant general superintendent there since last December.



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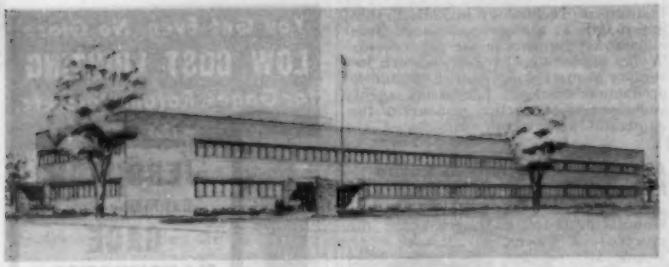


NEW OFFICE BUILDING PLANNED—Universal Oil Products Company of Chicago has approved plans by Olsen and Urbain, Chicago architects, for construction of a general office building to be erected at Des Plaines, Ill. The two story building will measure 360 x 75 feet, and will accommodate development, engineering, design, service and administration departments, as well as quarters for Procon, Inc., a UOP subsidiary. The 54 acre tract provides for future additions of a laboratory, pilot plant and other facilities. Contractor for the project is Henry Ericsson Company of Chicago.

David Conklin Appointed to Du Pont District Sales Post

David H. Conklin has been appointed assistant director of sales for the Petroleum Chemicals Division of E. I. du Pont de Nemours and Company (Inc.) with direct responsibility for district sales offices. Joseph L. Stecher will continue as assistant director of sales of the division in direct charge of products and services.

Conklin steps up from sales promotion manager for petroleum chemicals, and as a member of the plant's development section of the Organic Chemicals Department. A Du Pont employe since 1947, he has also served as manager of the division's west coast district office in Los Angeles. Conklin is a graduate of the University of Michigan with a B.S. in mechanical engineering.

Charles Wirth, III, named manager of wholesale sales in the Kinetic Chemicals Division of the Organic Chemicals Department, joined Du Pont in 1939 as a technical demonstrator and has been assigned as a manager of the mid-continent district office for petroleum chemicals at Tulsa and as eastern manager. He holds an M.S. degree in chemistry from Tulane University, and before joining Du Pont served as technical service representative of Universal Oil Products Company.

Reviewing European Factories

Henry S. Bamford, president of the Electronic Tube Corporation of Philadelphia, is making an extensive tour of Europe for the purpose of reviewing electronic manufacture. In line with his firm's specialization in multi-gun and other special purpose cathode ray tubes, Bamford plans to visit leading tube manufacturers throughout the Continent. He will return early in the fall.

Langhammer Adds B-I-F Division

Builders-Providence, Inc., and Omega Machine Company, divisions of B-I-F Industries, Providence, R. I., recently appointed E. G. Langhammer, president of Texas Filter Company of San Antonio, Texas, to be sales representative for their equipment. Langhammer already represents %Porportioneers, Inc.%, another division of B-I-F Industries.

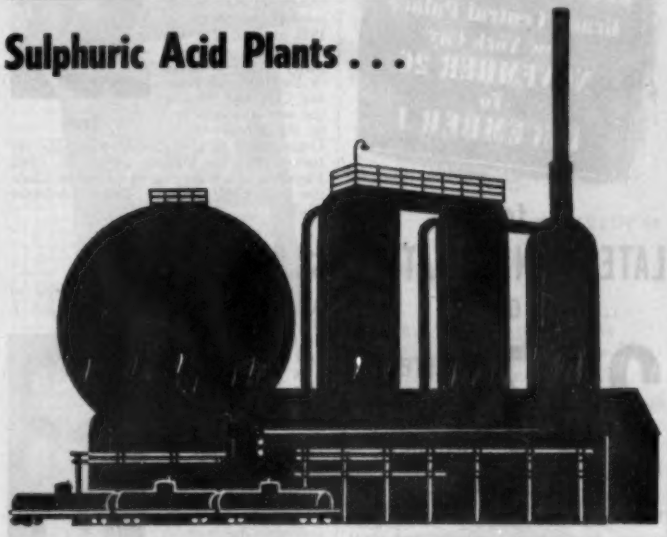
Rockwell Appoints Bradford To Represent Nordstrom Valves

F. J. Bradford has been appointed Special Sales Representative for Nordstrom valves, a manufacture of Rockwell Manufacturing Company. Bradford, a resident of Houston, attended both the University of Kansas and the University of Oklahoma. He has 18 years experience in selling oil field equipment throughout the mid-continent and Gulf Coast areas.

Bryant Appointed General Purchasing Manager for G-E

C. W. Bryant, appointed manager of the purchasing section of General Electric's Materials and Purchasing department, was formerly purchasing agent of ferrous products. A graduate of Carnegie

Sulphuric Acid Plants . . .



CONCENTRATORS and Recovery Plants

Nicolay Titlestad Corp. offers a specialized engineering service for those seeking experience, initiative, and engineering in building, or modernizing acid plants and concentrators of all types and sizes.

Inquiries invited. No obligation.

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23rd Exposition of CHEMICAL INDUSTRIES
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To research directors, laboratory technicians, development engineers, and plant executives concerned with the chemical aspects of petroleum processing, this great Exposition offers a timely opportunity . . . to *see and study* informative exhibits and demonstrations of 247 different kinds of materials and equipment of specific interest to processing industries . . . to *learn* how latest developments in industrial chemistry can be fitted to present operations . . . to *get* a wealth of new ideas for reducing costs, increasing production efficiency, improving products, modernizing and expanding facilities, and coping with today's equipment and materials supply situation . . . to *discuss* present problems and future plans first-hand with technical men in yours and related processing industries.

In no other way can you get so many new ideas in so little time as at this outstanding Exposition. Be sure to attend!

MANAGEMENT INTERNATIONAL EXPOSITION CO.

Institute of Technology in 1931, Bryant joined G-E as a student engineer. Subsequent assignments in the Schenectady Works included cost reduction work, inventory control supervisor, assistant to production manager, purchasing agent, and assistant production manager of the Apparatus department.

American Meter Names Payne Manager Chicago Sales Area

American Meter Company, Inc., manufacturers of instruments for the control of gases, steam, air, oil and other fluids, named Calvin N. Payne district sales manager of the Chicago sales territory. Payne, a graduate of Princeton University, joined the firm in 1921 at Erie, Pa. He has served as company representative in Denver and Kansas City and during the war was attached to the Production Department at the Erie factory. He returned to the Denver office in 1946. Payne is a member of the Denver Club, the Erie Club and the Illinois Athletic Club.

Payne

Sol Jacobson Elected Union Malleable President

The Union Malleable Company of Ashland, Ohio, recently elected Sol J. Jacobson president of Union Malleable and its subsidiaries, The Ashland Malleable Iron Company and The Union Brass & Copper Company. Sol Jacobson succeeds his brother Jack who died recently while on a trip to the west coast. Jack Jacobson was the founder and long-time president of The Union Malleable, while his brother, Sol, had been serving as vice president for the past several years.

Jacobson

Continental Supply Company Makes Personnel Changes

George P. Daley, field salesman at Marvey, La., has been appointed Store Manager at the same location for Continental Supply Company. Jack R. Barron, assistant store manager at Kilgore, Texas, has been appointed store manager at Palestine, Texas.

Builders-Providence Promotions Name Lauderdale and Brown

Richard L. Lauderdale, sales engineer of Builders-Providence, Inc., has joined the engineering sales staff of Builders-Pacific, Inc., of Berkeley, Calif. Lauderdale, who has been specializing in Chlorinizer sales engineering, is a graduate of the University of Oklahoma and is a member of the American Society of Civil Engineers.

Another transfer within the Builders-Providence organization concerns Walter H. Brown who was transferred

You Get Even, No Glare
LOW COST LIGHTING
for Gages, Rotameters, etc.
with
JERGUSON
Explosion-Proof
GAGE
ILLUMINATORS

Single and Double Section Jerguson Illuminators on a 3-Section Gage.

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YOU get even, no glare, Low Cost Lighting with Jerguson Gage Illuminators . . . the improved illuminators that are unexcelled for gages, rotameters, etc. They give you ideal illumination with safety . . . and make possible faster, easier, accurate reading.

Jerguson Illuminators use the principle of solid wedge lighting to give you *clear, even lighting, without bright spots.* Light flows through the plastic wedge and is reflected evenly. A single small bulb gives you better illumination at a cost so low that savings quickly pay for the illuminator.

Jerguson Illuminators are approved by Underwriters' Laboratories and are built in accordance with their Standard for Electric Lighting Fixtures for use in hazardous locations for Class 1, Group D Services. Made in a variety of sizes; also available in a non-explosion proof model.

Investigate Today. Write for Data Unit on Jerguson Illuminators

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Gages and Valves for the Observation of Liquids and Levels
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Representatives in Major Cities
Phone Listed Under JERGUSON
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from sales engineer in the Standard and Engineered Products to the Projects department. A graduate of Brown University, Brown is a licensed professional engineer in R. I. He was superintendent of sewage treatment for Cranston, R. I., for nearly seven years and is a member of ASME, the New England Sewage Works Association, and the Board of Control of the Federation of Sewage and Industrial Water Associations.

General Controls Appoints Andrews to Dallas Office

S. D. Andrews was appointed branch manager of the Dallas office for General Controls Company of Glendale, Calif. He joined the company three years ago at its San Francisco branch. Prior to joining the company he was a partner in a firm specializing in the installation of industrial lubricating equipment, and had been employed by North American Aviation Company and the Alemite Company of Southern California before that.

Andrews

As Dallas branch manager he will have charge of all territory activities. He replaces Robert Farmer, who will return to the Glendale plant as a factory engineer.

Turco Products to Market Dye Penetrant for Metal Inspection

Northrop Aircraft, Inc., awarded an exclusive license to Turco Products, Inc., of Los Angeles, for the manufacture and marketing of all materials used in the Dy-Check dye penetrant inspection process. Developed by Northrop for inspection of high performance gas turbine parts, the Dy-Check process proved it had wide application in the metals industries throughout the nation.

Turco will manufacture Dy-Check materials at its main Los Angeles plant as well as in branch factories at Houston, Chicago, and Newark, N. J. Because Turco is engaged in industrial chemical production, it maintains chemical laboratories and manufacturing facilities adaptable to production of Dy-Chek materials.

The Dy-Chek process depends upon the controlled use of a red dye, together with other liquids, to indicate the presence in metal of cracks or other flaws too small to be seen even with a magnifying glass.

33 M-H Graduates Assigned To 23 Defense Area Cities

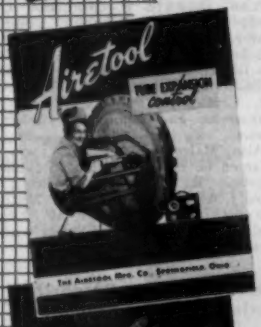
In further recognition of the increased tempo of the national defense program, Minneapolis-Honeywell Regulator Company has added 33 new sales engineers to 23 strategic defense areas throughout the country. The entire group recently completed a comprehensive course in industrial instrument maintenance and repair. Classes were held at the Brown division school in Philadelphia. The men and cities to which they were assigned are:

Albert F. Sommer, New York City; John E. Tutty, East Orange, N. J.; James V. Collins and Robert F. Trump,

"MUST" reading

for the man in charge of tube maintenance and repair

Before you purchase tube maintenance equipment, read what AIRETOOL has to say:



Tube Expanding Control—Tube rolling time is cut in half with this new accurate tube rolling control.

BULLETIN 47

The Refinery Catalog—Your buying guide for proper cleaning, expanding and maintaining refinery tubes.

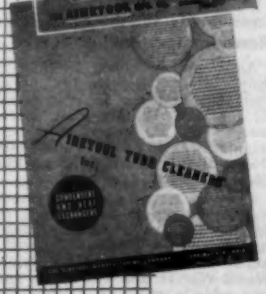
BULLETIN 48

Ball-Bearing Motors—Facts [redacted] a better job.

BULLETIN 49

Condenser Cleaners—Specially desi[redacted] and [redacted]

BULLETIN 40



AIRETOOL is the FIRST NAME in refinery tube cleaners, expanders and tube maintenance equipment. To get your copies of the colorful bulletins shown above, write The AIRETOOL Mfg. Co., 316 S. Center St., Springfield, Ohio.

There's an AIRETOOL Tube Cleaner and Tube Expander for Every Type of Tubular Construction

BRANCH OFFICES: New York, Philadelphia, Chicago, Tulsa, Baton Rouge, Houston

SAFE
STRONG
SECURE

Before specifying or purchasing open steel flooring check these exclusive features of Blaw-Knox Grating . . .

1. SAFETY underfoot at all times assured by twisted steel cross bars.
2. STRENGTH that only rigid "one-piece" Electroforged construction can provide.
3. SECURITY—no wobble, tilt or rattle caused by loose or lost screws, nuts, bolts.
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OF BLAW-KNOX COMPANY
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STEEL GRATING
AND STAIR TREADS

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Also, Donald P. Moreland, Cleveland; Joseph A. Hamblin, Columbus, Ohio; John E. Flaherty, Dayton; Jack W. Larsen, Wilton A. Bass and Vendel W. Immel, Detroit; Thomas H. Jenkins, William H. Johnson and John L. Matter, Chicago; Paul K. Webster, Indianapolis, and Philip A. Barker, St. Louis.

Also, Malcolm L. Johnson, Twin City; Warren G. Hardy, Carl T. Stevens and Herman R. Hampton, Houston; Bernard J. Alberts and Julius H. Matherne, New Orleans; George W. Leggett, Tulsa, and Frank G. Fischer and Michael J. Joncich, Los Angeles.

Machler to Direct Research; Perley, Williams Promoted

Appointment of Dr. Raymond C. Machler of Germantown, as director of research and a member of the executive committee of Leeds & Northrup Company has been announced. Dr. Machler succeeds I. Melville Stein who recently was elected to the newly created post of executive vice president.

Machler

Dr. Machler is a graduate of Northwestern University where he received B.S. M.S. and Ph.D. degrees. He joined Leeds & Northrup in 1929 as a research engineer and physicist, later becoming associate director of research in 1948.

Newly appointed to the posts of associate director of research are G. A. Perley and A. J. Williams, Jr. Both formerly were assistants to the director in the research department.

Canavan Is Washington Sales Manager for Insulux Blocks

American Structural Products Company appointed Richard J. Canavan district sales manager in Washington, D. C., for their Insulux glass block. He succeeds A. F. Meyers, who resigned recently. The company is a subsidiary of Owens-Illinois Glass Company, Toledo, Ohio.

Canavan leaves the post of technical director for Producers' Council, Inc., in Washington. An architectural engineering graduate of Iowa State College, Ames, Iowa, he is a Navy veteran of World War II, and was at one time district sales manager in Atlanta, Ga., for the Ingersoll Steel Division of Borg-Warner Corporation.

Alfred York, Watson-Stillman Executive, Dies After Illness

Alfred C. York, director and vice president of the Watson-Stillman Company of Roselle, N. J., died at his home in Elizabeth, N. J., after a prolonged illness.

York, named assistant treasurer in

For
TOP EFFICIENCY
INSULATED
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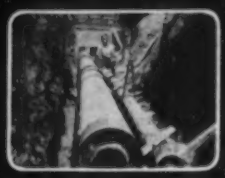
SYSTEMS



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OR
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BEST CHOICE

For distribution of steam or hot water, oils or process liquids, Ric-wiL Prefabricated Insulated Piping will provide your piping system with maximum sealed-in protection and efficiency.

Architects, engineers, and contractors have long recognized the reliability of Ric-wiL engineering and manufacturing of high-efficiency insulated piping—factors that insure long trouble-free life of industrial, commercial, and residential piping systems.

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Ric·wiL PREFABRICATED INSULATED PIPING — UNDERGROUND OR OVERHEAD

Corrosion Protection for All Metal Surfaces

Hysol 4000 Coatings

Whatever the cause of corrosion, Hysol Coatings will give up to 10 years of absolute protection. Equally effective immersed in liquids or exposed to corrosive atmospheres, these coatings take the form of tough chemical and abrasion-resistant films. They can be applied by your own personnel without special equipment. With proper application strong adhesion to all metal surfaces is assured. *Write for technical data.*

- Resistant to salt water and practically all chemicals.
- Applied by brush, roll, spray or dip methods.
- Finish coat in eight colors.

Houghton laboratories, inc.
OLEAN, NEW YORK

Plants at OLEAN, N. Y., and SMETHPORT, PA.

1918 shortly after joining Watson-Stillman Company, held that position until named assistant to the president. In this capacity he started and developed the Distributor Products Division. Elected vice president and general sales manager in 1941, he was later elected to the board of directors and took full charge of the Distributor Products Division.

He was a member of the Society of the Plastics Industry, the A.P.I. and the Manufacturers Standardization Society of the Valve and Fittings Industry, and was on the national board for the Standardization of Fittings.

Airco Promotes Vietor to Houston as District Manager

G. F. Vietor, Jr., was appointed Houston district manager of Air Reduction Magnolia Company, a division of Air Reduction Company, Inc. He will make his headquarters at Houston, Texas, where he will have sales responsibility for the Houston district with branch offices at San Antonio, Beaumont and Corpus Christi, Texas.

Vietor, Jr.

A graduate of Yale University, Vietor joined Air Reduction in 1939. After a five year period with the U. S. Navy during the war, he returned to Airco and did sales work in the East. He was promoted from assistant manager of the Boston district to his present position.

Japanese Peace Meet Delegates Impressed by Industrial Way

Eight Japanese Diet delegates to the San Francisco Japanese Peace Conference visited The Cooper-Bessemer Corporation and Mount Vernon, Ohio, to obtain an accurate cross section of a typical American city and to gather data on an American industrial plant. They specified Cooper-Bessemer as the result of a State Department motion picture produced several years ago which used the industrial organization and the community, as typical organization.

The Japanese visitors witnessed American productivity in action, watched workers apply incentive skill to modern precision machine tools. The quantity of work turned out particularly awed them.

Marley Resumes Production As Kansas City Flood Recedes

Damage done by three weeks of severe flood waters has been repaired and production resumed at The Marley Company, Inc., plant at Kansas City, Kansas. During the emergency period all production and service functions for the company were assumed by plants in Louisville, Ky., Stockton, Calif., and Houston, Texas, where stocks of products are maintained or can be manufactured.

G-E Appoints Schorr Specialty Department Sales Manager

Edmund C. Schorr, appointed manager of sales of the General Electric Company's Specialty Transformer and Ballast Department at Fort Wayne, Ind., assumed his new responsibilities September 1. Assistant manager of sales for

KEROTEST

FORGED STEEL
NEEDLE VALVES
FOR
- HIGH PRESSURE
- CORROSIVE SERVICES

4000 W.O.G.

Forged steel safety union bonnet type that permits repacking under full pressure. Supplied in specific materials for ordinary or corrosive services—globe or angle styles. N20 and N21 types for working pressures to 4000 lbs. W.O.G. Sizes ⅛" to ¾". Write for bulletin 49-N.

Note how union nut locks bonnet to body. Cannot back off. Assures safe repacking under pressure. Stem back seats for safety. Conical stem tip provides micrometer throttling action and positive seal.

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MANUFACTURING COMPANY
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IMPROVE CONTROL OF FLUID FLOW AND SHUT-OFF

24" stainless steel butterfly valve with Cono-Control air diaphragm operator and auxiliary hand wheel control; operation at high temperature.

20" rubber-lined butterfly valve with air cylinder and counterweight; for corrosive vapors at 215°F.

30" butterfly valve for 60 p.s.i. operating pressure; equipped with Janette electric motor operator.

Pipe up to W. S. ROCKWELL Automatic Butterfly VALVES

For air, gases, liquids, semi-solids—corrosive or abrasive—hot or cold—at pressures to 100 p.s.i., Rockwell Butterfly Valves provide controlled flow and quick shut-off that's automatic and trouble-free.

Made in all pipe sizes to 72", any metal or rubber-lined; may also be manually controlled.

Ask to be put on list to receive monthly issue of the Valve News about Rockwell Butterfly and Slide Valves.

W. S. ROCKWELL CO.
250 Eliot St., Fairfield, Conn.

the past year, Schorr served in the company's Chicago office from 1943 until 1950 as a specialty transformer and ballast specialist.

He is a native of St. Paul, Minn., and was graduated from the University of Minnesota in 1936 with a B.S. degree in electrical engineering. He joined G-E in 1940 at Schenectady, N. Y., on the company's Test Course.

Corcoran Joins New York Sales Group for Kaylo Division

J. A. Corcoran, Ridgewood, N. J., is assigned to the New York branch office of the Kaylo Division of Owens-Illinois Glass Company. He recently completed a training period at Owens-Illinois. A graduate of St. Bonaventure University with an engineering and business administration degree, he represents the Kaylo Division in the sale of its hydrous calcium silicate heat insulating and building products.

Corcoran

Corcoran previously had nine years experience in the insulation field with The M. W. Kellogg Company and three years with the Lummus Company.

Weatherhead Announces Nine Representatives of Products

The Weatherhead Company, Cleveland, Ohio, manufacturers of tubing and pipe fittings, appointed nine more industrial distributors to carry various Weatherhead products. Appointed to handle Weatherhead ERMETO Steel Fittings and Brass Fittings are: B. H. Deacon Company, Inc., American & Huntingdon Streets, Philadelphia 33; Knox, Inc., 33 Union Street, East Walpole, Mass.; Spence Tool & Rubber Company, 1530 North Adams Street, Peoria 3, Ill.; P. T. Standard Parts Company, 88 Douglas Street, Pontiac 16, Mich.; Diesel Injection Sales & Service, 808 Union Street, Norfolk 10, Va.; The Harry Cornelius Company, 1510 North 2 Street, Albuquerque, N. M.

In Akron and Massillon, Ohio, The Hardware & Supply Company are appointed distributors; Hydro Pneumatics, Inc., 90 West Street, New York 6; and by Robins Rubber Division of A. K. Robins & Company, Inc., Candler Building, Baltimore 2, Md.

Three Chicago Sub-Offices Opened by Hagan Corporation

Three sub-offices of the recently established Chicago district office of Hagan Corporation, Pittsburgh combustion and chemical engineering firm, have been opened. The offices also serve Hall Laboratories, Inc., Calgon, Inc., and The Buromin Company, subsidiaries of Hagan Corporation.

Art Soderberg is in charge of the sub-office at Rockford, Ill., which covers the northern half of Illinois and Iowa and portions of Wisconsin. Wilf Chapman is in charge at the Peoria sub-office, serving southern Illinois and Iowa. Otto Lessa will direct the Indianapolis office, covering portions of Indiana. The Chicago district office, established February, 1951, is directed by Harry E. Morton.

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ESPECIALLY RECOMMENDED FOR USE IN THE
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is preferred by leading refineries because of its high copper content, dependable uniformity and exceptional purity and freedom from foreign and inert matter.

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Quotations on request, on any quantity required. Shipments can be made from our nearest plant.

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Is your cooling tower meeting design specifications . . . giving trouble-free operation?

Is it . . . free of accumulative algae . . . safe from structural failure . . . subject to accelerated deterioration?

Does it have . . . full decking in good repair . . . minimum drift loss efficiency?

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NET WEIGHT 15 LBS.

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GERONIMO will stand hardest wear and give unfailing protection to refinery and derrick men whose lives are endangered by fire, escaping gases or other hazards.

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BRONZE "No-Spark" SURFACES
RECOMMENDED FOR ½" WIRE LINE

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MANUFACTURER WANTED

Are you interested in expanded sales in the petroleum and chemical equipment and process fields? Two sales-engineers having fifteen years' experience, each with separate nationally prominent concerns, are organizing a sales office in New York. We have developed custom and standard equipment sales in the millions and count among our personal friends hundreds of live buying contracts, large and small, in industry, government and export. Among these are the most desirable accounts in the East. This wealth of contacts, training and experience can be yours without any investment in cost or time.

If you have a fairly well equipped shop, can fabricate competitively and conduct business using ethical engineering practices we can accelerate your progress through profits. Because we are top-flight engineers as well, we will establish you in a broader range of sales by an intensive promotion of your present lines and by developing for you newer and more lucrative products.

If you are the manufacturer we would like to represent we can show you in black-and-white the unusual opportunity being offered by this hard hitting, ground covering, well connected team. Box 105-R, PETROLEUM REFINER, Houston, Texas.

Process Engineer who has had at least five years refinery experience. Southwest refinery. Box 102-R, Petroleum Refiner, Houston, Texas.

American Cyanamid Elects Eight Company Executives

Election of several American Cyanamid Company executives to new positions was announced as follows: E. D. Powers, vice president in charge of production, was elected to the board of directors. He succeeds H. P. Eastman who will retire August 31st. A. J. Campbell, general manager of the industrial chemicals division, and Howard Huston, formerly assistant to the president, were elected vice presidents. L. C. Duncan was elected assistant to the president.

Other executive changes announced were the election of J. J. Murray and G. C. Walker as assistant treasurers, and J. W. King and W. B. Ward as assistant comptrollers.

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CALIBRATING TANKS
for displacement meters.
Any capacity — Any Specification.
Write For Bulletin
WARNER LEWIS COMPANY
P. O. BOX 3096-D • TULSA, OKLA.

McKee Opens Tulsa Offices To Expand Southwest Service

Arthur G. McKee & Company, Cleveland, Ohio, engineers and contractors in the petroleum refining and iron and steel industries, opened an engineering office at Tulsa, Okla. McKee maintains offices in Cleveland and at Union, New Jersey. The Tulsa office will be headed by R. P. Mase who has been the Company's Southwest sales representative and who formerly was the chief engineer of the Jones & Laughlin Supply Company, Engineering and Construction Division, Tulsa, Okla.

HELP WANTED

Mechanical Engineer who has had actual supervisory experience in refinery of machine shop, pump, engine and turbine repair. Southwest refinery. Box 101-R, Petroleum Refiner, Houston, Texas.

OPPORTUNITIES FOR

TECHNICAL REFINERY PERSONNEL

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LARGE INTERNATIONAL OIL COMPANY

Entertaining applications of graduate chemical, mechanical, structural and electrical engineers for refinery engineering assignments at home and abroad.

Engineers with refinery experience and also recent graduates will be considered.

Box 196-R, Petroleum Refiner, Houston, Texas

PROCESS ENGINEER with at least 4 years' Refinery experience, including Crude Operations, Vacuum Operations, Catalytic Cracking, and Polymerization. Midwest Refinery. Box 104-R, Petroleum Refiner, Houston, Texas.

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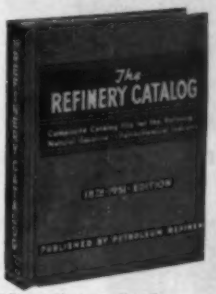
in the September, 1951, issue of

Petroleum Refiner

* The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1951 Refinery Catalog.



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Air Reduction Magnolia Co. 255
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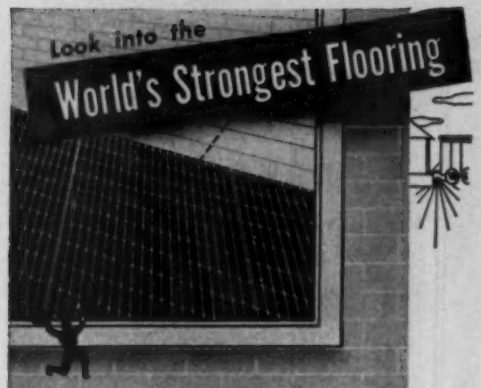

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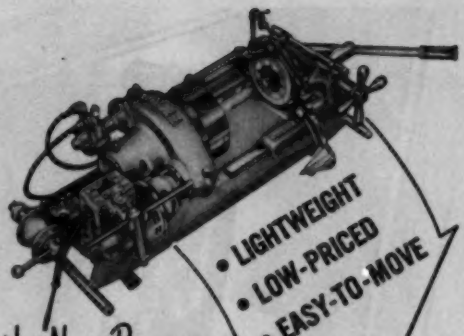

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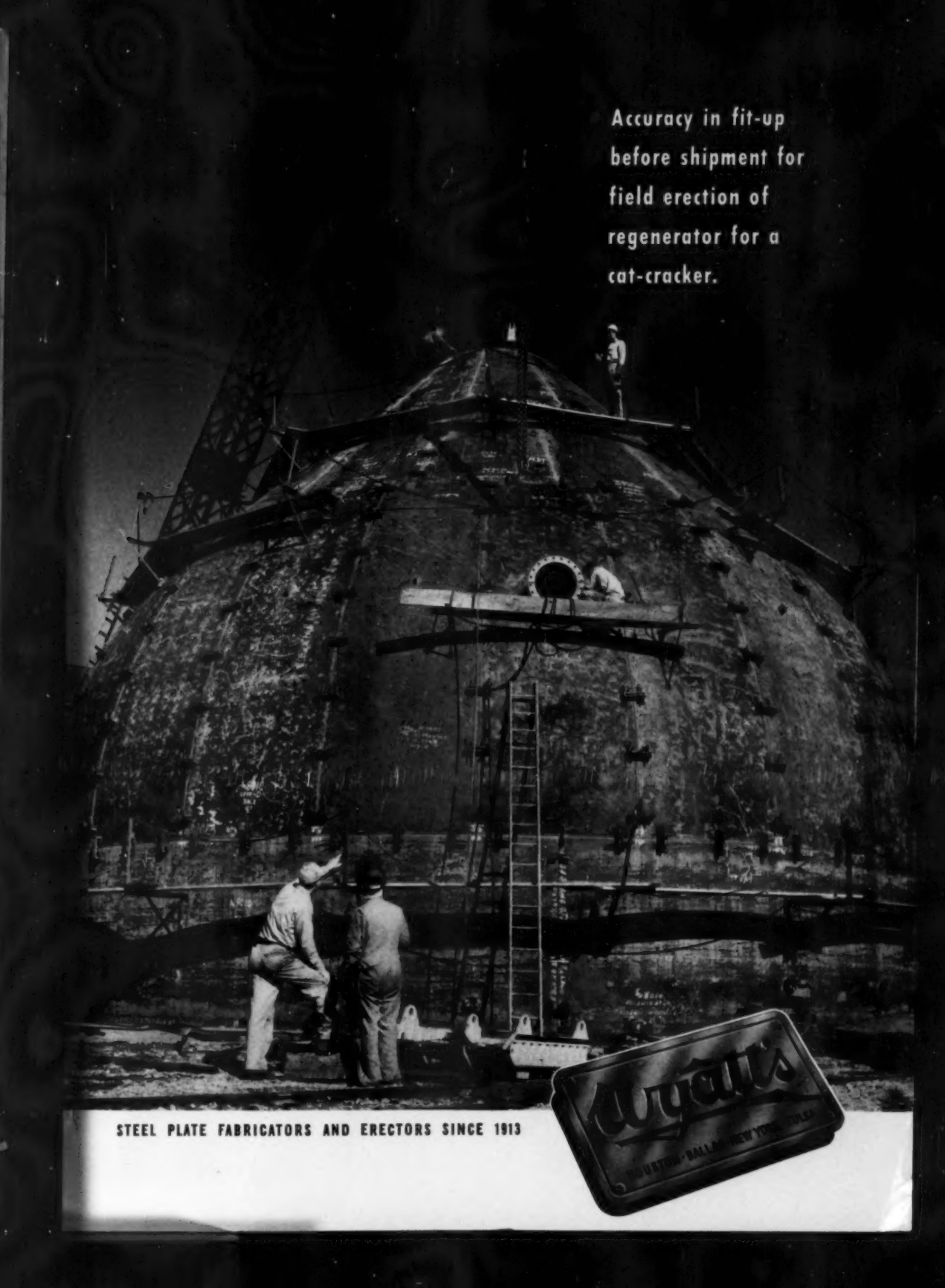
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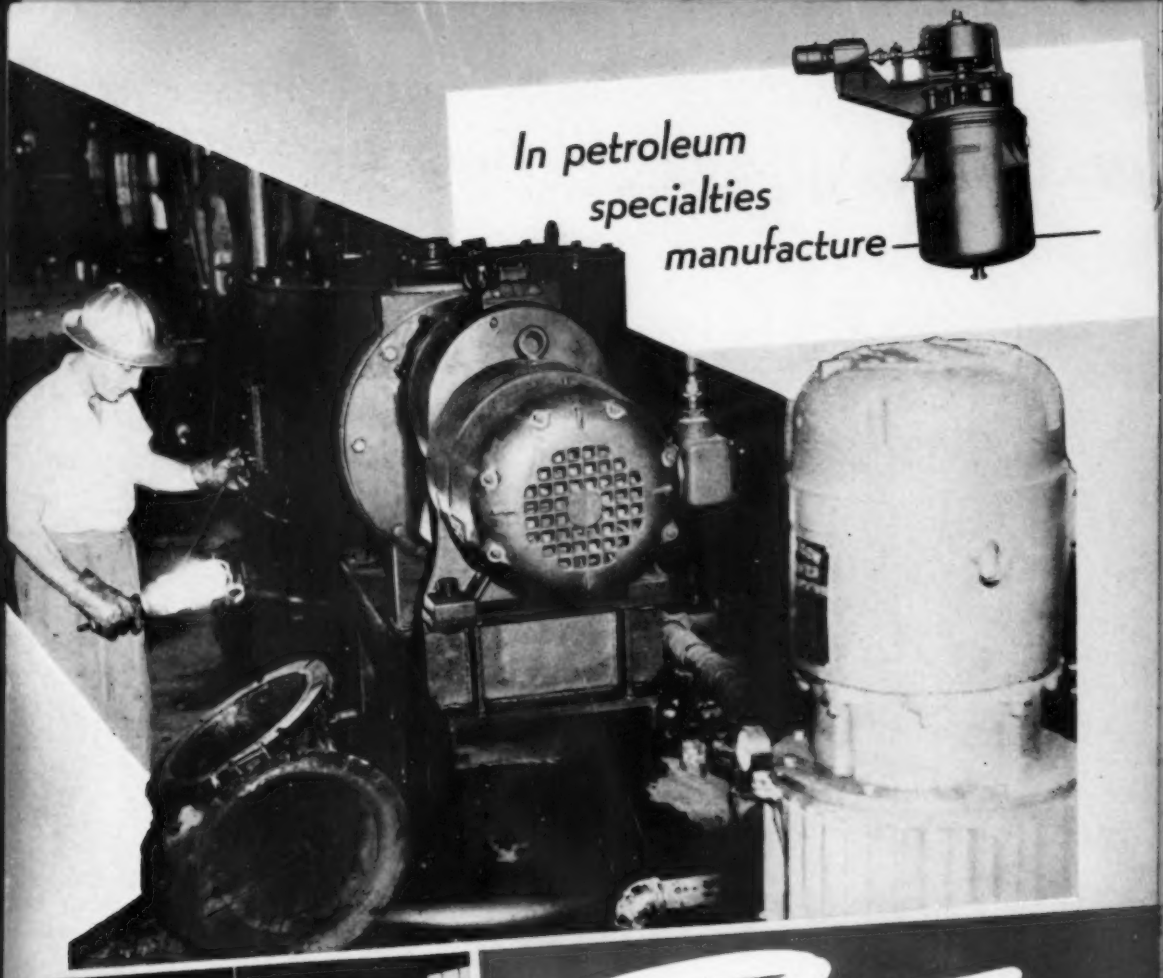

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